D.9 Geology and Soils

This section describes the affected environment for Geology and Soils and analyzes environmental impacts to these resources that are expected to result from the implementation of the Proposed Project. The following discussions address existing environmental conditions in the affected area, identify and analyze environmental impacts, and recommend measures to reduce or avoid adverse impacts anticipated from Project construction and operation. In addition, existing laws and regulations relevant to geologic and seismic hazards are described. In some cases, compliance with these existing laws and regulations would serve to reduce or avoid certain impacts that might otherwise occur with the implementation of the project. Section D.9.1 presents the affected environment for Geology and Soils. Relevant regulations and standards are summarized in Section D.9.2. Sections D.9.3 through D.9.5 describe the impacts of the Proposed Project and the alternatives. Section D.9.6 presents the mitigation measures and mitigation monitoring requirements, and D.9.7 lists references cited.

D.9.1 Environmental Setting / Affected Environment

D.9.1.1 Regional Setting and Approach to Data Collection

Baseline geologic, seismic, and soils information was collected from published and unpublished literature, GIS data, and online sources for the project and the surrounding area. Data sources included the following: previous reports and studies related to the Lake Gregory Dam provided by the County of San Bernardino, geologic literature, maps, and GIS data from the U.S. Geological Survey and California Geological Survey, soils data from the U.S. Department of Agriculture, and other online reference materials. The literature review was supplemented by a field reconnaissance of the proposed and alternative routes. The literature review and field reconnaissance focused on the identification of specific geologic hazards and soil conditions.

The study area was defined as the locations of Project components and the areas immediately adjacent to the project components for most geologic and soils issue areas with the following exception: the study area related to seismically induced ground shaking includes significant regional active and potentially active faults within 50 miles of the project.

Physiography

The West of Devers Upgrade Project route is near the junction of three major physiographic provinces in California: the northern edge of the Peninsular Ranges, the southern edge of the Transverse Ranges, and the northwestern edge of the Colorado Desert. The route skirts the edges of fault-bounded mountain ranges, and crosses desert features such as badlands (i.e., barren dissected and eroded hills and gullies that are formed in semiarid regions with sparse vegetation and that experience high rates of erosion, usually formed in areas underlain by soft or weakly cemented fine grained geologic units), alluvial fans, and pediments. The Peninsula Ranges are a northwest trending set of fault-bounded mountains and valleys, south of the Transverse Ranges, and in the project area include the northern end of the San Jacinto Mountains and the hills known as the San Timoteo Badlands. The Colorado Desert region lies mostly at a low elevation and consists of desert basins with interspersed northwest-trending mountain ranges.

The northern end of the Proposed Project starts at the San Bernardino Substation which is located in the southern San Bernardino Valley. At the southern end of the north-south section, near the San Bernardino Junction, it crosses a low set of hills that are part of the San Timoteo Badlands and San Timoteo Creek. The east-west section of the route starts at Vista Substation and crosses I-215 before entering the San Timoteo

Badlands. The route crosses several stands of the San Jacinto Fault before exiting the hills. The route traverses the Badlands hills parallel to San Timoteo creek until the eastern end of the hills where it exits into Cherry Valley.

The route continues east skirting the southern foothills of the San Bernardino Mountains, making excursions into the valley occupied by the cities of Banning and Beaumont. This valley between the San Bernardino Mountains on the north, and the San Jacinto Mountains of the Peninsular Ranges geomorphic province on the south, is known as the San Gorgonio Pass. The proposed West of Devers route exits the San Gorgonio Pass east of Whitewater Canyon. The project ends at Devers Substation, which is located near the western edge of the Colorado Desert region at the northeastern edge of the Coachella Valley.

Geology

The West of Devers portion of the proposed route is underlain primarily by sedimentary units ranging in age from Holocene to Pliocene, with lesser amounts of Cretaceous granitic rocks near the western end. It generally traverses alluvial plains, alluvial fans and pediments, badlands, and hills. General descriptions of the geologic materials, listed chronologically, crossed by the proposed West of Devers segments are summarized in Table D.9-1. The regional geology of the Proposed Project area is presented in Figure D.9-1, Geologic Map.

Table D.9-1. Summary of Geologic Units along the West of Devers Segment

Formation	Age	Description/Comment	Excavation Characteristics[1]
Qw – Wash Deposits	Holocene	Alluvial deposits occurring in modern washes of rivers and streams.	Easy
Qyf – Younger Fan Deposits	Holocene	Alluvial fan deposits of sand and gravel.	Easy
Qya – Younger Alluvium	Holocene	Slightly dissected alluvial deposits of sand and gravel.	Easy
Qal – Recent Alluvium	Holocene	Unconsolidated alluvial fan, river channel, and stream deposits consisting of silt, sand, clay, and gravel.	Easy
Qow – Older Wash Deposits	Holocene	Alluvial deposits of abandoned washes or intermittently active alluvium of older washes.	Easy
Qof – Older Fan Deposits	Holocene to Pleistocene	Moderately dissected fan deposits of sand and gravel.	Easy
Qc – Nonmarine Sedimentary Deposits	Pleistocene	Older alluvium and fanglomerate, dissected with well-developed desert pavement and desert varnish in some areas. Consists of clay, siltstone, sand, and gravel. Locally consists of Burnt Canyon Breccia, Heights Fanglomerate, in the San Gorgonio Pass.	Easy
Qco – Nonmarine Sedimentary Deposits	Pleistocene	Older folded or uplifted fan deposits, very dissected. Locally extensively folded and faulted. Consists of conglomerate, sandstone, and clay; boulder conglomerate in some areas along the margins of the Coachella Valley. Locally consists of Cabazon Fanglomerate in the Whitewater River area and of Ocotillo Conglomerate near the margins of Coachella Valley.	Easy
Pc/QTst – San Timoteo Formation	Plio-Pleistocene	Nonmarine sandstone, siltstone, conglomerate, and shale, forms extensive badlands in the Redlands area.	Easy to Moderate
Kgr – Granitic Rocks	Cretaceous	Granitic rock of several types, primarily quartz monzonite and granodiorite.	Difficult

Source: CGS, 1966 & 1986.

1 Excavation characteristics are very generally defined as “easy,” “moderate,” or “difficult” based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Slope Stability

Important factors that affect the slope stability of an area include the steepness of the slope, the relative strength of the underlying rock material, and the thickness and cohesion of the overlying colluvium. The steeper the slope and/or the less strong the rock, the more likely the area is susceptible to landslides. The steeper the slope and the thicker the colluvium, the more likely the area is susceptible to debris flows. Another indication of unstable slopes is the presence of old or recent landslides or debris flows.

Much of the proposed WOD route crosses gently sloping to flat terrain with some gently sloping hills and does not cross any large areas identified as existing landslide or landslide hazard. However, the project route crosses the gentle to moderately sloping hills of the San Timoteo Badlands (Segments 1, 2 and 3) where landslides are common throughout the area and several large landslide deposits occur on the east side of the San Jacinto Fault near the north end of the badlands (Morton & Miller, 2006).

San Bernardino County maps the San Timoteo Badlands area as having moderate to high landslide susceptibility (SBC, 2010) and the Riverside County General Plan maps the area as having numerous existing landslides and as having a high susceptibility to landslides and/or rockfalls (RCPD, 2003). The City of Grand Terrace noted that there are areas of unstable slopes in Grand Terrace and Colton. These unstable areas were observed in site visits as well. Additional unmapped landslides and areas of localized slope instability may be encountered in any of the hills traversed by the Proposed Project alignment.

While several of the existing towers along the slopes north of Vista Grande Way would be retained and only slightly modified, two towers would be replaced at slightly different locations by proposed structures 2N29 and 2N32. Unstable slopes may be encountered during construction at these two locations, and geotechnical studies would be required to ensure that new structures are safely installed.

Soils

The soils along the route reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of human modification. Potential hazards/impacts from soils include erosion, shrink-swell (expansive soils), and corrosion. Soil mapping by the USDA Natural Resources Conservation Service (NRCS) for the State of California (NRCS, 2006) and review of soil data accessed through the NRCS Web Soil Survey website (NRCS, 2014) have provided information for surface and near-surface subsurface soil materials. A summary of the significant characteristics of the major soil associations traversed by the West of Devers segments, listed in numerical not geographic order, and the segments they occur on is presented in Table D.9-2. Figure D.9-2 shows the distribution of these soil associations within the project area.

Table D.9-2. Major Soils along the Proposed West of Devers Upgrade Project Route

Unit ID	Soil Association	Segment	Description	Shrink/ Swell Potential	Risk of Corrosion	
					Concrete	Uncoated Steel
s991	Myoma-Carsitas-Carrizo	Segment 5 and Segment 6	Formed in alluvial fans and sand blown from alluvial deposits. May include some areas of desert pavement and desert varnish.[1] Soil types include gravelly and gravelly coarse sand, very gravelly sand, stony sand, and fine to very fine sand.	Low	Low	High

Table D.9-2. Major Soils along the Proposed West of Devers Upgrade Project Route

Unit ID	Soil Association	Segment	Description	Shrink/ Swell Potential	Risk of Corrosion	
					Concrete	Uncoated Steel
s995	Rock Outcrop–Rillito-Beeline-Badland	Segment 6	These soils are formed in alluvium and vary from shallow gravelly sandy and sandy loam[2] to deep gravelly sandy loam and gravelly loam.	Low	Low to Moderate	Moderate to High
s999	Ramona-Placentia-Greenfield-Linne	Segment 1, Segment 3, Segment 4, and Segment 5	Formed in alluvium weathered from Granitic rocks and in material weathered from sandstone and shale. Soil types include fine sandy to sandy loam, sandy clay loam, and sandy clay to clay loam.	Low to High	Low to Moderate	Low to High
s1004	Ramona-Greenfield-Hanford-Gorgonio	Segment 1, Segment 2, and Segment 4	Formed in alluvium on fans and terraces from granitic rocks. Consists of fine sandy loam, sandy loam, and gravelly loamy fine sand.	Low to Moderate	Low to Moderate	Low to High
s1010	Sesame–Rock Outcrop–Cieneba	Segment 2	Includes outcrops of bare rock. Shallow to moderately deep soils formed in material weathered from Granitic rocks. Soil types include fine gravelly loam, gravelly loam, and sandy to sandy clay loam.	Low to Moderate	Low to Moderate	Low to High
s1027	Urban Land–Tujunga–Soboba-Hanford	Segment 2 and Segment 6	Formed in alluvium derived primarily from granitics and includes fine sandy loam, sand, loamy sand, and gravely to stony loamy sand.	Low to Moderate	Low to Moderate	Low to High
s1036	Xerorthents-Saugus–San Timoteo-Badland	Segment 1, Segment 2, Segment 3, Segment 5, and Segment 6	Formed in material primarily weathered from sedimentary rock such as shale and sandstone. Soil types include loam, sandy loam, and silt loam.	Low to Moderate	Low to Moderate	Moderate to High

Source: NRCS STATSGO California GIS data, 2006; NRCS website, 2014.

1 - A desert pavement is a desert surface that is covered with closely packed, interlocking angular or rounded rock fragments of pebble and cobble size. Desert varnish is the thin red to black coating found on exposed rock surfaces in arid regions. Varnish is composed of clay minerals, oxides and hydroxides of manganese and/or iron. Both desert pavement and desert varnish take thousands of years to form.

2 - Loam soil composed of sand, silt, clay, and organic matter in evenly mixed particles of various sizes.

Potential soil erosion hazards vary depending on the use, conditions, and textures of the soils. The properties of soil which influence erosion by rainfall and runoff affect the infiltration capacity of a soil, as well as the resistance of a soil to detachment and being carried away by falling or flowing water. Soils on steeper slopes would be more susceptible to erosion due to the effects of increased surface flow (runoff) on slopes where there is little time for water to infiltrate before runoff occurs. Soils containing high percentages of fine sands and silt and that are low in density, are generally the most erodible. As the clay and organic matter content of soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion.

Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay. Soils with moderate to high shrink-swell potential would be classified as expansive soils.

Corrosivity of soils is generally related to the following key parameters: soil resistivity; presence of chlorides and sulfates; oxygen content; and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. High sulfate soils are corrosive to concrete and may prevent complete curing reducing its strength considerably. Low pH and/or low resistivity soils could corrode buried or partially buried metal structures.

Faults and Seismicity

The seismicity of southern California is dominated by the intersection of the north-northwest trending San Andreas Fault system and the east-west trending Transverse Ranges fault system. Both systems are responding to strain produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, left-lateral strike slip on the Garlock fault, and vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. The effects of this deformation include mountain building, basin development, deformation of Quaternary marine terraces, widespread regional uplift, and generation of earthquakes. The Transverse Ranges, which includes the San Bernardino Mountains, are characterized by numerous geologically young faults. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999):

- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit aseismic fault creep are defined as Historically Active.
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as Active.
- Faults that show geologic evidence of movement during the Quaternary time (approximately the last 1.6 million years) are defined as Potentially Active.
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as Inactive.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Blind thrust faults do not intersect the ground surface, and thus they are not classified as active or potentially active in the same manner as faults that are present at the earth’s surface. Blind thrust faults are seismogenic structures with no surface expression and thus the activity classification of these faults is predominantly based on geologic data from deep oil wells, geophysical profiles, historic earthquakes, and microseismic activity along the fault.

The project area will be subject to ground shaking associated with earthquakes on faults of the San Andreas and Transverse Ranges fault systems. Active faults of the San Andreas system are predominantly strike-slip faults accommodating translational movement. The Transverse Ranges fault system consists primarily of blind, reverse, and thrust faults accommodating tectonic compressional stresses in the region. This combination of translational and compressional stresses gives rise to diffuse seismicity across the region.

The most significant faults in the project area are faults of the San Andreas Fault Zone. The San Andreas Fault Zone is a 680-mile active right-lateral strike-slip complex of faults that has been responsible for many of the damaging earthquakes in Southern California in historical times. The San Andreas Fault Zone is the longest active fault in California and represents the boundary between the Pacific and North American plates. Historically, the San Andreas Fault has produced “great” earthquakes that have caused significant surface rupture in southern California, such as the January 9, 1857, Magnitude (M) 8 Fort Tejon earthquake. Surface rupture associated with this earthquake was extensive, from northwest of Parkfield in Monterey County extending southeastward for over 225 miles along the San Andreas Fault to the Cajon Pass northwest of San Bernardino (SCEDC, 2014a).

Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area through the lifetime of the Proposed Project, the effects of strong groundshaking and fault rupture are of primary concern to safe operation of the West of Devers Upgrade Project. Active faults that represent a significant seismic threat to the Proposed Project are listed in Table D.9-3. Data presented in this table include estimated earthquake magnitudes, type of fault, and slip rates. Figure D.9-3 shows locations of significant active faults and historic earthquakes in the project area and surrounding region.

Table D.9-3. Significant Active Faults in the West of Devers Upgrade Project Vicinity

Fault	Closest Distance to Project (miles)	Closest Project Component	Maximum Estimated Earthquake Magnitude	Type of Fault and Dip Direction
San Andreas: San Bernardino section	0	Segment 6	7.3	right lateral strike slip, 90°
San Andreas: San Gorgonio Pass section	0	Segments 4 & 5	7.1	Reverse/Thrust, 60°
San Jacinto: San Bernardino Valley section	0	Segments 2 & 3	7.1	right lateral strike slip, 90°
San Jacinto: San Jacinto Valley section	1.2	Segment 3	7.0	right lateral strike slip, 90°
Pinto Mountain	6.5	Segment 6	7.3	left lateral strike slip, 90°
San Jacinto: Anza section	12	Devers-Valley to Banning Telecom	7.3	right lateral strike slip, 90°
Sierra Madre	12.5	Segment 2	7.2	reverse, 45°N
North Frontal Fault Zone – West	17.5	Segment 1	7.2	reverse, 45°S
Johnson Valley	18	Segment 6	6.9	right lateral strike slip, 90°
Elsinore: Glen Ivy section	19	Segment 2	6.9	right lateral strike slip, 90°
Elsinore: Temecula section	20	Segment 2	7.1	right lateral strike slip, 90°
San Andreas: Mojave section	21	Segment 1	7.3	right lateral strike slip, 90°
San Andreas: Coachella segment	21	Segment 6	7.0	right lateral strike slip, 90°
Whittier	22	Segment 2	7.0	right lateral reverse oblique, 75°N
Camp Rock–Emerson–Cooper Mountain	27.5	Segment 6	7.1	right lateral strike slip, 90°
Helendale–South Lockhart	28.5	Segment 5	7.4	right lateral strike slip, 90°
Lenwood-Lockhart-Old Woman Springs	29	Segment 6	7.5	right lateral strike slip, 90°

Notes:
(a) Fault distances measured from USGS GIS Quaternary fault data (USGS and CGS, 2010).
(b) Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is "Ellsworth-B" magnitude from USGS OF08-1128 (Documentation for the 2008 Update of the United States National Seismic Hazard Maps) unless otherwise noted.
(c) Range of Magnitudes represents varying potential rupture scenarios with single or multiple segments of the fault rupturing in various combinations.
(d) Fault parameters from USGS OF08-1128 (Documentation for the 2008 Update of the United States National Seismic Hazard Maps) unless otherwise noted

Fault Rupture

Fault rupture is the surface displacement that occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture and displacement almost always follows preexisting faults, which are zones of weakness; however, not all earthquakes result in surface rupture (i.e., earthquakes that occur on blind thrusts do not result in surface fault rupture). Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. In addition to damage caused by ground shaking from an earthquake, fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset leading to damage or collapse of structures across this zone.

A major factor to be considered in the seismic design of electric transmission lines crossing active faults is the amount and type of potential ground surface displacement along faults. The West of Devers route segments cross faults of the San Jacinto fault zone (SJFZ) and San Andreas fault zone (SAFZ) capable of significant surface rupture (Figure D.9-3, Active Faults and Historic Earthquakes), including from west to east, the Claremont and Yorba Linda faults of the SJFZ, and the San Gorgonio Pass, Garnet Hill, and South Branch faults of the SAFZ.

In the southern San Bernardino Mountains and San Gorgonio Pass areas the San Andreas fault zone is comprised of an extremely complex zone of right-lateral strike-slip, reverse-oblique, and thrust faults. The Holocene to late Quaternary Garnet Hill Fault is approximately 16 miles in length and passes near the communities of Whitewater, Palm Springs, and North Palm Springs. The San Gorgonio Pass fault zone is an approximately 22-mile thrust fault located near the communities of Banning, Cabazon, and Beaumont and is Holocene to late Quaternary in age. The South Branch fault (also referred to as the Banning Fault) generally parallels I-10 north of the San Gorgonio Fault Zone for approximately 25 miles. The fault passes close to the communities of Banning, Cabazon, and Whitewater. The South Branch fault's most recent rupture was during Holocene time.

Near the communities of Loma Linda and Grand Terrace, the proposed route crosses active segments of the San Jacinto Fault Zone. The San Jacinto Fault is one of the major faults of Southern California, approximately 130 miles in length and generally parallel and west of the San Andreas fault. It is an active right-lateral strike-slip complex of faults that has been responsible for many of the damaging earthquakes in Southern California. Future earthquakes could occur anywhere along the various strands and associated faults (including currently unknown faults) of this zone.

The West of Devers Upgrade Project route also crosses several potentially active faults, the Rialto-Colton fault of the SJFZ, the Live Oak Canyon fault of the Crafton Hills fault zone, and the Beaumont Plain fault zone. The Crafton Hills fault zone consists of a series of normal faults, each approximately 6 miles long or less, that have been formed by the regional extension created near the intersection of the San Andreas and San Jacinto fault zones. The faults trend northeast in the vicinity of the Crafton Hills, but adopt more easterly trends near the San Bernardino strand of the San Andreas fault and south of Redlands. The Beaumont Plain fault zone is a set of northwest-trending en-echelon normal dip-slip faults that traverse late Quaternary alluvial deposits in the vicinity of Beaumont that are likely also a result of the regional extension between the SAFZ and SJFZ (USGS, 2014a). Faults of the Beaumont Plain fault zone are not well defined at the surface due to development of the area. Fault strands of the Beaumont Plain fault zone have County of Riverside mapped County Fault Zones which are similar to Alquist-Priolo zones for faults with potential for damaging fault rupture (RCPD, 2003).

Strong Groundshaking

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a Moment Magnitude (M) scale because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than M 7.0, the Moment and Richter Magnitude scales are nearly identical. For earthquake magnitudes greater than M 7.0, readings on the Moment Magnitude scale are slightly greater than a corresponding Richter Magnitude. Review of earthquake data for the project area indicates that approximately 15 earthquakes of greater than magnitude 6.0 have occurred within 50 miles of the Proposed Project, including the M 7.3 Landers Earthquake and several of its aftershocks which include the 6.5 Big Bear Earthquake (SCEDC, 2014). These earthquakes are shown on Figure D.9-3. A summary of significant M 6.0 or greater earthquake events is presented in Table D.9-4.

Table D.9-4. Significant Historic Earthquakes Affecting the West of Devers Project Vicinity

Date	Earthquake Name or General Location	Fault Involved, if Known	Magnitude	Approximate Closest Distance to Project Alignment
October 16, 1999	Hector Mine Earthquake	Lavic Lake and Bullion	7.15	48 miles northeast
June 28, 1992	Landers Earthquake	Johnson Valley, Landers, Homestead Valley, Emerson, Camp Rock, and others	7.3	20 miles northeast
June 28, 1992	Big Bear Earthquake – aftershock of the Landers Earthquake	Unnamed fault	6.5	15 miles north
April 23, 1992	Joshua Tree – likely an aftershock of the Landers Earthquake	Eureka Peak	6.2	15 miles northeast
July 8, 1986	North Palms Springs Earthquake	Banning or Garnet Hill	5.9	4.5 miles northwest
December 4, 1948	Desert Hot Springs Earthquake	Banning or So San Andreas	6.0	11 miles east
March 11, 1933	Long Beach Earthquake	Newport-Inglewood	6.4	46 miles southwest
July 22, 1923	North San Jacinto Fault Earthquake	San Jacinto	6.3	2 miles south
April 21, 1918	San Jacinto Earthquake	San Jacinto	6.8	14 miles south
May 15, 1910	Elsinore Earthquake	Elsinore	6.0	25 miles southwest
December 25, 1899	San Jacinto Fault Earthquake, located southeast of San Jacinto	San Jacinto	6.5	11 miles south
July 22, 1899	Cajon Pass Earthquake	Uncertain	6.4	21 miles northwest
February 2, 1890	San Jacinto or Elsinore Fault region	Uncertain	Estimated 6.5 to 6.8	40 miles southeast
December 8, 1812	Wrightwood Earthquake	San Andreas	7.5	29 miles northwest

Source: SCEDC Website, 2014b.
Notes: Magnitude is moment magnitude (MW) for earthquakes after 1911. For earthquakes before 1911, magnitudes are estimated from observed shaking intensity. Earthquake magnitudes and locations before 1932 are estimated based on reports of damage and felt effects.

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the project area. Earthquakes occurring on faults closest to the project area would most likely generate the largest ground motion. The intensity of earthquake-induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). GIS data for the USGS National Seismic Hazards (NSH) Maps were used to estimate approximate peak ground accelerations (PGAs) in the Proposed Project area (USGS, 2014b). The NSH Maps depict peak ground accelerations with a 2 percent probability of exceedance in 50 years which corresponds to a return interval of 2,475 years for a maximum considered earthquake. The intensity of earthquake-induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). The estimated peak ground accelerations for the West of Devers Upgrade Project range from 0.8 to 1.2 g for the entire route which represents a potential for strong to severe groundshaking along the project route.

Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong groundshaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur.

In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of groundshaking; and (c) the depth to groundwater. Much of the project route is mapped as potentially liquefiable by the San Bernardino and Riverside Counties (SBC, 2010 and RCPD, 2003). In the San Bernardino Valley, water tables are high and liquefaction is a known geologic hazard. In the San Gorgonio Pass areas underlying the project alignment mapped as recent alluvium are mapped by Riverside County as having moderate liquefaction susceptibility (RCPD, 2003). Portions of the project route where it crosses drainages and valleys underlain by young alluvial deposits may be susceptible to liquefaction. However, young alluvial deposits underlying portions of Segments 4, 5, and 6 are not generally expected to be liquefiable due to deep groundwater levels in these areas, greater than 300 feet. Older consolidated sedimentary deposits, fine or coarse grained deposits, and/or well-drained sedimentary materials are not susceptible to liquefaction.

Seismic Slope Instability/Ground Cracking

Other forms of seismically induced ground failures which may affect the project area include ground cracking and seismically induced landslides. Landslides triggered by earthquakes have been a considerable cause of earthquake damage; in southern California large earthquakes such as the 1971 San Fernando and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. Areas that are underlain by landslide-prone units, such as Grand Terrace and Colton, north of Vista Grande Way, and the San Timoteo Formation (located along Segments 2, 3, and 4), with moderate to steep slopes, and previously existing landslides, both mapped and unmapped, are particularly susceptible to this type of ground failure.

D.9.1.2 Environmental Setting by Segment

D.9.1.2.1 Segment 1: San Bernardino

Geology

This segment of the Proposed Project exits San Timoteo Canyon at the San Bernardino Junction and goes due north across the San Bernardino Valley to the San Bernardino Substation. This segment crosses several Quaternary sedimentary units: wash deposits (Qw), younger fan deposits (Qyf), younger alluvium (Qya), and San Timoteo Formation (QTst). Descriptions of these units are listed in Table D.9-1. The Segment 1 portion of the new 220 kV Transmission Line crosses San Timoteo Formation (QTst) from towers 1W01 and 1E3/1W3, younger fan deposits (Qyf) from towers 1E4/1W4 to 1E7/1W7, wash deposits (Qw) at towers 1E18/1W18 and 1E8/1W8 to 1E9/1W9, and younger alluvium (Qya) from towers 1E19/1W19 to 1E26/1W26 and 1E17/1W17 to 1E10/1W10. The two new 66 kV subtransmission lines in Segment 1 are primarily located within younger alluvium (Qya) including of all the project components of the San Bernardino–Timoteo-Redlands line and all project components except poles 89 to 95 along the San Bernardino–Redlands-Tennessee line, poles 89 to 95 are located in wash deposits (Qw).

Slope Stability

The moderately sloping hills near the San Bernardino Junction, which includes proposed Towers 1W01 and 1E3/1W3, are underlain by landslide-prone San Timoteo Formation.

Soils

The Segment 1 route traverses hills and the San Bernardino Valley floor between the San Bernardino Substation and the San Bernardino Junction. The soils at the southern end of Segment 1 are classified as soil association s1036, Xerorthents-Saugus–San Timoteo–Badland; and those in the valley are classified primarily as s1004, the Ramona-Greenfield-Hanford-Gorgonio association. The southern end of the San Bernardino–Redlands-Tennessee subtransmission line (from approximately Citrus Ave.) is mapped as s999, the Ramona-Placentia-Greenfield-Linne association. General characteristics of these soils are described in Table D.9-2. General location of these soil associations along the project route are shown on Figure D.9-2.

Seismicity

Fault Rupture. This segment crosses the northwestern end of the potentially active Live Oak Canyon fault (a segment of the Crafton Hills fault zone) near the San Bernardino Junction location, as shown on Figure D.9-4a. This fault is not designated as an Alquist-Priolo Earthquake Fault Zone and has been obscured by development in some areas. No planned tower locations are near the mapped trace of this fault.

Groundshaking. This segment of the proposed route is located near and adjacent to several known active faults and thus will be subject to strong to severe groundshaking in the event of a local earthquake. Estimated PGA values for this segment are between 0.8 to 1.2g.

Liquefaction. Liquefaction is possible in the San Bernardino Valley near the Santa Ana River due to the high water table and the occurrence of granular, unconsolidated materials in the subsurface (Matti and Carson, 1991). However, only the northern ends (north of Victoria Ave.) of Segment 1 and the associated subtransmission lines lie in an area identified as having moderate susceptibility to liquefaction (SBC, 2010).

Earthquake-Induced Landslides. Landslides and ground cracking are likely to occur in the landslide-prone San Timoteo Formation underlying the hills at the southern end of Segment 1 near the San Bernardino Junction in the event of a large local or regional earthquake.

D.9.1.2.2 Segment 2: Colton and Loma Linda

Geology

This section of the proposed route between Vista Substation and San Bernardino Junction, from east to west, crosses the northern end of the San Timoteo Badlands, Reche Canyon, the northern end of the Box Spring Mountains, and an elevated stream terrace and alluvial fan. The route segment crosses San Timoteo Formation (QTst) from the San Bernardino Junction (tower 2N01) to approximately tower 2N18 and younger alluvial fan deposits from Reche Canyon from towers 2N19 to 2N22 and at tower 2N29. The terraces and low hills on the northern end of the Box Spring Mountains are underlain by granitic rocks (Kgr) from about tower 2N23 to tower 2N26. The western end of the segment, towers 2N32 to 2N35 are underlain by older wash deposits (Qow) and Vista Substation and towers 2N36 to 2N38 are underlain by older fan deposits (Qof). Descriptions of these units are listed in Table D.9-1.

Slope Stability

The hill slopes along Segment 2 from tower 2N01 to 2N18 are underlain by landslide-prone San Timoteo Formation. In addition, two of the several proposed structures (2N29 and 2N32) north of Vista Grande Way would replace structures located on steep slopes with potential for slope instability; other towers in the vicinity would be retained but their crossarms would be modified.

Soils

The Segment 2 route traverses hills and stream and river drainages and is underlain by four soil associations. The four associations, from east to west are Xerorthents-Saugus–San Timoteo-Badland (s1036), Ramona-Greenfield-Hanford-Gorgonio (1004), Sesame–Rock Outcrop–Cieneba (s1010), and Urban Land–Tujunga–Soboba-Hanford (s1027). General characteristics and a brief description of these soils are presented in Table D.9-2 and distribution of these soil units along Segment 2 is shown in Figure D.9-2.

Seismicity

Fault Rupture. This segment crosses several strands of the SJFZ, the potentially active Loma Linda and Rialto-Colton faults, and the active Claremont fault, as shown on Figure D.9-4b. The Loma Linda Fault consists of several small northwest oriented strands in the vicinity of towers 2N06 to 2N01. These strands are generally subparallel to the alignment; however, one strand does cross the alignment at or immediately adjacent to tower 2N04. The active, Alquist-Priolo zoned Claremont fault crosses Segment 2 about 300 feet northeast of tower 2N14. The Rialto-Colton fault crosses the alignment approximately 500 feet east of tower 2N22.

Groundshaking. This segment of the proposed route crosses and is located near to several known active faults and thus will be subject to strong to severe groundshaking in the event of a local earthquake. Estimated PGA values for this segment are between 0.8 to 1.2g.

Liquefaction. This segment is located primarily on semi-consolidated sedimentary units not expected to be liquefiable. Segment 2 does cross several river/stream drainages underlain by potentially liquefiable alluvial fan deposits; however, these areas are mapped as having low liquefaction susceptibility (SBC, 2010).

Earthquake-Induced Landslides. Much of the Segment 2 alignment is located along the hills of the San Timoteo Badlands which are underlain by the landslide-prone San Timoteo Formation; therefore it is likely that this area would experience earthquake-induced landslides and ground cracking in the event of a large local or regional earthquake.

D.9.1.2.3 Segment 3: San Timoteo Canyon

Geology

Segment 3 follows San Timoteo Canyon from El Casco Substation to San Bernardino Junction along the northeastern flank of the San Timoteo Badlands. These hills form the high point of the gap between the San Jacinto Mountains on the south and the San Bernardino Mountains on the north. The San Timoteo Canyon segment of the route is primarily underlain by San Timoteo Formation (Pc/QTst), except where the segment crosses San Timoteo Canyon and in small side drainages that are underlain by Recent/ Younger Alluvium (Qal/Qya) in the San Timoteo Canyon. Numerous small to medium-sized landslides are mapped in the San Timoteo Badlands where slopes are over-steepened or unfavorable bedding angles are exposed. Descriptions of these units are listed in Table D.9-1.

Slope Stability

The entirety of Segment 3 is located on gently to moderately sloping hills underlain by the landslide-prone San Timoteo Formation. Landslides are common in the San Timoteo Formation mapped along the Segment 3 alignment.

Soils

Two soil associations are mapped along Segment 3. The main soil association is the Xerorthents-Saugus–San Timoteo-Badland association (s1036), located along most of the Segment 3 alignment. Minor amounts of the Ramona-Placentia-Greenfield-Linne association (s999) soils are located at the east end underlying tower 3N03 and the El Casco Substation. Descriptions of these soil associations are presented in Table D.9-2. General characteristics and a brief description of these soils are presented in Table D.9-2 and distribution of these soil units along Segment 3 is shown in Figure D.9-2.

Seismicity

Fault Rupture. This segment crosses the trend of the potentially active Loma Linda Fault, a splay of the San Jacinto Fault Zone, at an oblique angle near the San Bernardino Junction, as shown in Figure D.9-4c. A small strand of the fault is located adjacent to and subparallel to the alignment, trending towards towers 3S62/3N62. This fault does not have a mapped Alquist-Priolo Zone associated with it.

Groundshaking. Much of this segment of the proposed route runs sub-parallel to the San Jacinto Fault Zone and is less than a mile northeast of the westernmost trace. The San Jacinto Fault is a major active fault that may generate up to a M 7.3 earthquake. Strong to severe groundshaking caused by a large local or regional earthquake should be expected to occur along this segment. Estimated PGA values for this segment are between 0.8 to 1.2g.

Liquefaction. Potential for liquefaction in this area is low due to anticipated groundwater depths of greater than 50 feet and the lack of noncohesive granular material in the uppermost 50 feet of the subsurface. Minor areas of liquefaction potential may be present in the alluvial sediments in San Timoteo Canyon near the creek; however, no towers are planned for this area.

Earthquake-Induced Landslides. Landslides are common in the San Timoteo Formation mapped along Segment 3 alignment. The alignment is located along the gently to moderately sloping hills of the San Timoteo Badlands which are underlain by a landslide-prone formation. Existing and new landslides could result in the event of a large local or regional earthquake.

D.9.1.2.4 Segment 4: Beaumont and Banning

Geology

This segment of the Proposed Project starts at the eastern end of San Timoteo Canyon and traverses east through San Gorgonio Pass along the southern flank of the San Bernardino Mountains to the southern outlet of Banning Canyon. Segment 4 of the 220 kV transmission route is primarily underlain by nonmarine sedimentary deposits (Qc), minor amounts of Recent alluvium (Qal) and San Timoteo Formation (Pc). The alignment crosses pockets of Recent alluvium at the following tower locations: 4N01/4S01 to 4N02/4S02, 4N35/4S35, 4N37/4S37, 4N58 to 4N59, 4S60, and 4N64. San Timoteo Formation is located where the alignment crosses the hills at the edge of the San Bernardino Mountains and is located underlying towers 4N3/4S3, 4N10/4S10 to 4N13/4S13, and 4N60/4S60 to 4N62/4S3. Descriptions of these units are listed in Table D.9-1.

Slope Stability

Most of Segment 4 is located on flat to gently sloping valley floor and alluvial fan surfaces and is not susceptible to landslide hazards. However, the Segment 4 alignment crosses moderately sloping hills and drainages along the southern edge of the San Bernardino Mountains between towers 4N19/4S19 and 4N02/4S02. This moderately sloping area is partially underlain by landslide-prone San Timoteo formation and could be susceptible slope failures.

Soils

Two soil associations are mapped along Segment 4, with the alignment underlain almost in its entirety by the Ramona-Placentia-Greenfield-Linne soil association (s999). Minor amounts of the Ramona-Greenfield-Hanford-Gorgonio soil association (s1004) are located at the east end of the segment underlying towers 4N01/4S01. General characteristics and a brief description of these soils are presented in Table D.9-2 and distribution of these soil units along Segment 4 is shown in Figure D.9-2.

Seismicity

Fault Rupture. This segment crosses several strands of the potentially active Beaumont Plain fault in Beaumont between Highway 10 and Beaumont Avenue, and a potentially active strand of the San Gorgonio Pass fault just north of Banning near Mountain Avenue, as shown in Figure D.9-4d. The Beaumont Plain fault zone is a set of relatively short northwest-trending en-echelon normal dip-slip faults with mapped County of Riverside County Fault Zones. Strands of the Beaumont Plain fault zone cross Segment 4 near towers 4N31/4S31 to 4N34/4S34, 4N36/4S36, and 4N39/4S39. Segment 4 crosses a potentially active strand of the San Gorgonio Pass fault at or immediately adjacent to towers 4N14/4S14.

Groundshaking. Much of this segment of the proposed route runs sub-parallel to the San Gorgonio and San Andreas Fault Zones and is less than 2 miles south of both zones. The San Jacinto Fault is approximately 5 miles south of Segment 4. A large local or regional earthquake on any of these nearby faults could produce strong to severe groundshaking along this segment. Estimated PGA values for this segment are between 0.8 to 1.2g.

Liquefaction. Potential for liquefaction in areas of this segment underlain by nonmarine sedimentary deposits and the San Timoteo Formation is low to very low due to the semiconsolidated nature of these units. Areas underlain by recent alluvium near San Timoteo Creek and in San Gorgonio Pass are mapped by the County as having a moderate potential for liquefaction. However, groundwater depths in the San Gorgonio Pass are anticipated to be greater than 300 feet, resulting in a very low potential for liquefaction. During storms or a wet season, temporary shallow perched groundwater may be present and sections of the proposed route that lie near the San Gorgonio River Wash may be moderately susceptible to liquefaction if a strong earthquake occurs while the valley floor sediments are saturated.

Earthquake-Induced Landslides. The Segment 4 alignment crosses moderately sloping hills and drainages along the southern edge of the San Bernardino Mountains between towers 4N19/4S19 and 4N02/4S02 that are partially underlain by the landslide-prone San Timoteo formation; these areas could be susceptible to earthquake-induced slope failures. The remainder of Segment 4 is located on flat to gently sloping valley floor and alluvial fan surfaces and would not be susceptible to earthquake-induced landslide hazards.

D.9.1.2.5 Segment 5: Morongo Tribal Lands and Surrounding Areas

Geology

This section of the Proposed Project continues to traverse east through San Gorgonio Pass along the southern flank of the San Bernardino Mountains, across the San Gorgonio River, and ending at Rushmore Avenue south of Stubbe Canyon. The Segment 5 route alignment is underlain by Recent alluvium (Qal), nonmarine sedimentary deposits (Qco), and minor amounts of San Timoteo Formation (Pc). Recent alluvium underlies most of this segment at towers 5N1/5S1 to 5N7/5S7, 5N11/5S11 to 5N12/5S12, 5N16/5S16 to 5N49/5S49, 5N54/5S54. Nonmarine sedimentary deposits (Qco) are located at towers 5N8/5S8 to 5N10/5S10 and 5N14/5S14 to 5N15/5S15, and San Timoteo Formation (Pc) underlies towers 5N52/5S52. Descriptions of these units are listed in Table D.9-1.

Slope Stability

Most of Segment 5 is located on flat to gently sloping valley floor, alluvial fan surfaces, and gently rolling hills and is not susceptible to landslide hazards. No landslides are mapped within the portion of the Segment 5 alignment that crosses the hills along the northern edge of the San Gorgonio Pass.

Soils

Three soil associations are mapped along Segment 5, with the most of the alignment underlain by the Ramona-Placentia-Greenfield-Linne soil association (s999). The eastern third, approximately, of the Segment 5 alignment is underlain by the Xerorthents-Saugus–San Timoteo-Badland (s1036) and the Myoma-Carsitas-Carrizo (s991) soil associations. General characteristics and a brief description of these soils are presented in Table D.9-2 and distribution of these soil units along Segment 5 is shown in Figure D.9-2.

Seismicity

Fault Rupture. This segment roughly parallels the complex Gorgonio Pass fault, which is an active fault with a designated Alquist-Priolo Zone, and crosses it six times, as shown in Figure D.9-4e. The likely type of faulting to occur in this area is primarily thrust faulting with a component of right lateral slip, and an up-on-the-north sense of displacement and shortening in the north-south direction. The amount of fault offset will likely be a few feet, some of which may be vertical.

Groundshaking. Strong groundshaking could be caused by an earthquake on any of the faults in the vicinity of this segment. This Segment crosses and runs sub-parallel to the San Gorgonio fault zone. Estimated PGA values for this segment are between 0.8 to 1.2g, although, in the vicinity of the San Gorgonio Pass fault zone, the directionality of peak ground acceleration may be more vertical than horizontal as the San Gorgonio Fault Zone is likely to generate a thrust earth-quake with primarily vertical movement. Groundshaking can become focused along favorably aligned ridgelines and hilltops causing higher than normal accelerations and ground movements.

Liquefaction. Potential for liquefaction in areas of this segment underlain by nonmarine sedimentary deposits and San Timoteo Formation is low to very low due to the semiconsolidated nature of these units. Areas underlain by Recent alluvium in San Gorgonio Pass are mapped by the County as having a moderate potential for liquefaction. However, groundwater depths in the San Gorgonio Pass are anticipated to be greater than 300 feet, resulting in a very low potential for liquefaction. During storms or a wet season, the water table may rise and sections of the proposed route segment that lie near the San Gorgonio River Wash may be moderately susceptible to liquefaction if a strong earthquake occurs while the valley floor sediments are saturated.

Earthquake-Induced Landslides. The Segment 5 alignment crosses gently sloping hills along the southern edge of the San Bernardino Mountains between towers 5N7/5S7 and 5N11/5S11 that are cut by the San Gorgonio Pass fault zone which could produce an earthquake with significant shaking and vertical motion. Groundshaking or fault rupture from an earthquake on this fault could destabilize slopes that would otherwise not be prone to landslides in static conditions. The remainder of Segment 5 is located on flat to gently sloping valley floor and alluvial fan surfaces and would not be susceptible to earthquake-induced landslide hazards.

D.9.1.2.6 Segment 6: Whitewater and Devers

Geology

Segment 6 continues to traverse east through San Gorgonio Pass along the southern flank of the San Bernardino Mountains, across the Whitewater River, along Garnet Wash and ending within the western edge of the Coachella Valley at Devers Substation. The Segment 6 alignment and all the associated Segment 6 components are underlain by Recent alluvium (Qal) and nonmarine sedimentary deposits (Qco). Recent alluvium underlies this segment at towers 6N10/6S10 to 6N12/6S12, 6N15/6S15 to 6N24/6S24, and 6N39/6S39 to 6N48/6S48. Nonmarine sedimentary deposits (Qco) are located at towers 6N13/6S13 to 6N14/6S14, 6N25/6S25 to 6N27/6S27, and 6N28/6S28 to 6N38/6S38. Descriptions of these units are listed in Table D.9-1.

Slope Stability

Most of Segment 6 is located on flat to gently sloping valley floor, alluvial fan surfaces, and gently rolling hills and is not susceptible to landslide hazards.

Soils

Four soil associations are mapped along Segment 6, with the most of the alignment underlain by the Myoma-Carsitas-Carrizo (s991) and the Xerorthents-Saugus–San Timoteo-Badland (s1036) soil associations. The remaining two Soils associations underlie the Segment 6 route in the vicinity of Whitewater Canyon, the Urban Land–Tujunga-Soboba-Hanford (s1027) and the Ramona-Placentia-Greenfield-Linne (s995) soil associations. General characteristics and a brief description of these soils are presented in Table D.9-2 and distribution of these soil units along Segment 6 is shown in Figure D.9-2.

Seismicity

Fault Rupture. This segment is crossed by several Alquist-Priolo zoned strands of the San Andreas fault zone, as shown in Figure D.9-4f. This segment crosses the active trace of the San Andreas South Branch fault (also known as the Banning fault) just west of Devers Substation at an oblique angle at and near towers 6N10/6S10. Potential fault offset along the Garnet Hill fault could be as much as 15 feet of right-lateral displacement. The alignment crosses the northern end of the Garnet Hill fault at an oblique angle between towers 6S29 and 6S38 and between towers 6N30 and 6N34; in this area the Garnet Hill fault has been affected by the San Gorgonio Pass fault zone and is split into several short anastomosing fault strands. These strands of the Garnet Hill fault are all included in state designated Alquist-Priolo Zones. Two strands cross the northern Segment 6 alignment at or near to proposed tower locations, 6N31 and 6N32. Segment 6 crosses, at an oblique angle, a portion of an Alquist-Priolo Zone for a third strand of the Garnet Hill fault near tower 6S36; however, it does not cross the fault associated with this Alquist-Priolo Zone.

Groundshaking. Strong groundshaking could be caused by an earthquake on any of the faults in the vicinity of Segment 6. This Segment crosses and runs sub-parallel to two strands of the SAFZ, the Garnet Hill fault and South Branch San Andreas fault (Banning fault). Estimated PGA values for this segment are between 0.8 to 1.2g, corresponding to strong to severe groundshaking for this area.

Liquefaction. Potential for liquefaction in areas of this segment underlain by nonmarine sedimentary deposits is low to very low due to the semiconsolidated nature of these units. Areas underlain by Recent alluvium in San Gorgonio Pass, crossing Whitewater Canyon, and along the western edge of the Coachella Valley are mapped by the County as having a moderate potential for liquefaction. However, groundwater depths in these areas are anticipated to be greater than 50 feet, resulting in a low potential for liquefaction.

Earthquake-Induced Landslides. The Segment 6 alignment crosses hills of the southern edge of the San Bernardino Mountains between towers 6N28 to 6N37, and 6S28 and 6S28A. These hills are cut crossed and adjacent to strands of the SAFZ and strong to severe groundshaking from an earthquake on one of these faults could destabilize slopes that would otherwise not be prone to landslides in static conditions. The remainder of Segment 6 is located on flat to gently sloping valley floor and alluvial fan surfaces and would not be susceptible to earthquake-induced landslide hazards.

D.9.1.3 Environmental Setting for Connected Actions

Desert Center Area. The solar projects in the Desert Center area are located in areas with BLM administered and private lands. The area includes the Mojave Desert geomorphic province, which is a broad interior region of isolated mountain ranges separated by expanses of desert plains. It has an interior enclosed drainage, with playas (dry lake basins) being common. Fault trends largely control Mojave Desert topography. Mountain ranges in the Mojave Desert are composed of complexly faulted and folded basement rocks that range in age from pre-Cambrian (more than 570 million years before present (mybp) to Mesozoic (66 to 240 mybp). Volcanic and sedimentary rocks deposited in the Cenozoic (less than 66 mybp to present) are common as well. Younger faulting in the eastern half of the Mojave Desert geomorphic is characterized by generally north- to northwest-trending normal faults associated with regional extension in the Basin and Range province. Chuckwalla Valley is bounded on the west by the Eagle Mountains, on the east by the Palen Mountains, and on the north by the Coxcomb Mountains. The Chuckwalla Valley contains a thick sequence of Quaternary sedimentary deposits, including Pleistocene fan deposits, Holocene alluvium, and dune sand. The bordering mountains expose primarily Precambrian metamorphic and Mesozoic granitic rocks. The Blue Cut and Pinto Mountain Fault Zones are the nearest active faults.

As reported in the Desert Harvest EIS (BLM, 2012), soils in the area are generally uniform and dominated by sandy texture. Sand dune deposits, younger alluvium, and older alluvium occur in the area, and exhibit low to very severe resistivity and are classified as having a very low expansion potential. The area contains desert pavement, which is rock fragments of pebble to cobble size that cover an underlying layer of sand, silt, or clay. Areas of desert pavement typically have little or no vegetation cover. The extent to which desert pavement reduces wind erosion and resulting fugitive dust depends on the density of the rock fragments covering the underlying soil. Desert pavements seem to form from two different processes. On rocky alluvial fans, fine dust settling out of the air accumulates between and below the surface layer of rocks, eventually forming a thin silt and clay layer that separates the surface rocks from the main part of the alluvial fan. Desert pavement also can form on sandy soils that contain significant amounts of gravel and rock fragments. In such situations, wind and water erosion can remove most of the sand and fine sediments from the surface, leaving the remaining rock fragments as the predominant surface layer.

Blythe Area. The Blythe area is on the eastern edge of the Colorado Desert Geomorphic Province in Riverside County. Within California, this geomorphic province encompasses an area that extends from the Colorado River on the east, the eastern Transverse Ranges on the north, the Mexican border on the south, and the Peninsular Ranges on the west. The Colorado Desert province is generally characterized by broad alluvial valleys separated by steep, discontinuous, sub-parallel mountain ranges that generally trend northwest-southeast. The Blythe area is in a seismically active region of Southern California within the Sonoran zone, which is a relatively more stable tectonic region than areas farther west. The California Geological Survey defines an active fault as one that has had surface displacement during the Holocene age (roughly the last 11,000 years). Potentially active faults are those that show evidence of surface displacement during the Quaternary age (roughly the last 1.6 million years) but for which evidence of Holocene movement has not been established. An inactive fault is one that has not shown evidence of surface displacement during the Quaternary age. The nearest faults to the Blythe Area are located in the McCoy Mountains and are inactive.

The area located west of Blythe and northeast of the Colorado River Substation, is generally underlain by Quaternary age alluvium consisting of unconsolidated to weakly consolidated sand, silt, and gravel. Surficial deposits of aeolian (windblown) sand, gravels, and minor fill also exist. Topsoil and alluvium (surficial soils) are also present.

D.9.2 Applicable Regulations, Plans, and Standards

Geologic resources and geotechnical hazards are governed primarily by state and local jurisdictions. State regulations and guidelines require compliance with building and safety codes related to seismic and other geologic hazards. The conservation elements and seismic safety elements of city and county general plans contain policies for the protection of geologic features and avoidance of hazards, but do not specifically address transmission line construction projects. Appendix 9 (Policy Screening Report) identifies various applicable requirements in local plans, including those related to geologic hazards. Relevant, and potentially relevant, statutes, regulations and policies are discussed below.

D.9.2.1 Federal

Clean Water Act. The Clean Water Act establishes the basic structure for regulating discharges of pollutants into the waters of the United States. The Act authorized the Environmental Protection Agency to prepare comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries and improving the sanitary condition of surface and underground waters with the goal of improvements to and conservation of waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural and industrial uses. Ground disturbance can lead to soil erosion and surface water runoff from a site, impairing nearby waterbodies. The Proposed Project construction would disturb a surface area greater than 1 acre; therefore, SCE would be required to obtain under Clean Water Act regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity. Compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP).

International Building Code. The International Building Code (IBC) is published by the International Code Council (ICC), the scope of this code covers major aspects of construction and design of structures and buildings, except for three-story one- and two-family dwellings and town homes. The International Building Code has replaced the Uniform Building Code as the basis for the California Building Code and contains provisions for structural engineering design. The 2015 IBC addresses the design and installation of structures and building systems through requirements that emphasize performance. The IBC includes codes governing structural as well as fire- and life-safety provisions covering seismic, wind, accessibility, egress, occupancy, and roofs.

D.9.2.2 State

California Building Code (CBC). The California Building Code, Title 24, Part 2 provides building codes and standards for design and construction of structures in California. The 2013 CBC is based on the 2012 International Building Code with the addition of more extensive structural seismic provisions. Chapter 16 of the CBC contains definitions of seismic sources and the procedure used to calculate seismic forces on structures.

CPUC General Orders 95 and 128. California Public Utilities General Order 95 (GO95) and General Order 128 (GO128) contain State of California rules formulated to provide uniform requirements for overhead electrical line construction and underground electrical supply and communication systems, respectively, to insure adequate service and secure safety to persons engaged in the construction, maintenance, operation or use of overhead electrical lines and underground electrical supply and communication systems and to the public. GO95 and GO 128 are not intended as complete construction specifications, but to embody requirements which are most important from the standpoint of safety and service. Construction shall be according to accepted good practice for the given local conditions in all particulars not specified in the rules.

GO95 applies to all overhead electrical supply and communication facilities which come within the jurisdiction of the California Public Utilities Commission, located outside of buildings, including facilities that belong to non-electric utilities, as follows: Construction and Reconstruction of Lines, Maintenance of Lines, Lines Constructed Prior to This Order, Reconstruction or Alteration, Emergency Installation, and Third Party Nonconformance.

GO128 applies to (a) all underground electrical supply systems used in connection with public utility service; when located in buildings, the vaults, conduit, pull boxes or other enclosures for such systems shall also meet the requirements of any statutes, regulations or local ordinances applicable to such enclosures in buildings; and (b) all underground communication systems used in connection with public utility service located outside of buildings. GO128 applies to the following activities related to underground electrical supply and communication systems: Construction and Reconstruction of Lines, Maintenance, Systems Constructed Prior to These Rules, Reconstruction or Alteration, and Third Party Nonconformance.

Alquist-Priolo. The Alquist-Priolo Earthquake Fault Zoning Act of 1972, Public Resources Code (PRC), sections 2621–2630 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. While this act does not specifically regulate transmission and telecommunication lines; it does help define areas where fault rupture is most likely to occur. This Act groups faults into categories of active, potentially active, and inactive. Historic and Holocene age faults are considered active, Late Quaternary and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geologic explorations in order to determine whether building setbacks should be established.

Seismic Hazard Mapping Act. The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter7.8, Division 2, sections 2690–2699.) directs the California Department of Conservation, Division of Mines and Geology [now called California Geological Survey (CGS)] to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and State agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones.

D.9.2.3 Local

The California Public Utilities Commission (CPUC) has jurisdiction over the siting and design of the Proposed Project because the CPUC regulates and authorizes the construction of investor-owned utility (IOU) facilities. Although such projects are exempt from local land use and zoning regulations and permitting, General Order (GO) No. 131-D, Section III.C requires "the utility to communicate with, and obtain the input of, local authorities regarding land-use matters and obtain any nondiscretionary local permits."

San Bernardino County. Construction and operation of the Proposed Project may be subject to policies and regulations contained within the San Bernardino County Development Code, and the San Bernardino General Plan which include policies and regulations for the avoidance of geologic hazards and/or the protection of unique geologic features. The Safety Element section of the San Bernardino County General Plan (County of San Bernardino, 2007) provides for mitigation of geologic hazards through a combination of engineering, construction, land use and development standards. The Plan addresses the geologic hazards present within the county, including fault rupture, ground shaking, liquefaction, seismically generated subsidence, seiche and dam inundation, landslides/mudslides, non-seismic subsidence, erosion and volcanic activity. The county has prepared Hazard Overlay Maps to address fault rupture, liquefaction hazards and landslide hazards. Special consideration, including possible engineering/geologic evaluation, is required for development of sites designated on the maps. Additionally, the County Building and Safety Department enforces Building Standards adopted by the State of California and the County of San Bernardino including the California Building Code contained in Title 24 of the California Code of Regulations.

Riverside County. Construction and operation of the Proposed Project may be subject to policies and regulations contained within the Riverside County Building Code and Land Use Ordinance, and the Riverside County General Plan. The County Building and Safety Department enforces Building Standards adopted by the State of California and Riverside County including the California Building Code contained in Title 24 of the California Code of Regulations and local codes and ordinances. The Riverside County Department of Building and Safety oversees and manages grading, building inspection and code enforcement within the County. The Riverside County General Plan Safety Element (Riverside County, 2008) presents a summary of geologic and other hazards in the County and facilitates the identification and mitigation of hazards for new development which in turn strengthens existing codes, project review, and permitting processes, and presents policies directed at identifying and reducing hazards in existing development. The County has prepared a Safety Element Technical Background Report that is an assessment of natural and man-made hazards in the County, including, but not limited to: earthquakes, landslides, subsidence/settlement, floods, inundation, and wildland fire. The report serves as the foundation for the Safety Element and includes detailed Geographic Information System (GIS) hazard mapping and analyses.

General Plans for incorporated cities along the project corridor often include policies and goals related to seismicity and other geologic risks. These are discussed in Appendix 9 (Policy Screening Report).

D.9.3 Environmental Impacts of the Proposed Project

D.9.3.1 Approach to Impact Assessment

A wide range of potential impacts, including landslides, debris flows and slope creep, and seismic hazards including surface fault rupture, strong groundshaking, liquefaction, and seismically induced landslides, was considered in this analysis. Geologic conditions were evaluated with respect to the impacts the project may have on local geology and soils, as well as the impact that specific geologic hazards and soils may have upon the proposed transmission line and its related facilities.

Geologic formations, slope conditions, and soil types have been characterized by their potential to contribute to hazardous conditions. Areas prone to risk for potential adverse impacts due to existing geologic, topographic, or soils conditions were identified and their relationship to Proposed Project components analyzed. Where existing conditions suggest a potential risk or impact, mitigation measures were identified to reduce the risk or impact.

D.9.3.1.1 Applicant Proposed Measures

SCE proposed no Applicant Proposed Measures (APMs) specific to geology and soils.

D.9.3.2 Impact Criteria

NEPA does not have specific significance criteria. However, NEPA regulations contain guidance regarding significance analysis. Specifically, consideration of “significance” involves an analysis of both context and intensity (Title 40 Code of Federal Regulations 1508.27). Using the following criteria for the purposes of analysis, the project or an alternative would impact geology and soils if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

  i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to Division of Mines and Geology Special Publication 42.

  ii) Strong seismic ground shaking.

  iii) Seismic-related ground failure, including liquefaction.

  iv) Landslides.

- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

D.9.3.3 Impacts and Mitigation Measures

This section presents discussion of impacts related to geologic, soil, and seismic conditions and mitigation measures for the West of Devers Upgrade Project. Geologic conditions were evaluated with respect to the impacts the project may have on local geology and soils, as well as the impact that specific geologic hazards may have upon the proposed transmission line and other Project-related components.

Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

Project facilities would be subject to hazards of surface fault rupture at crossings of active and potentially active faults. The project route crosses several active and potentially active faults including: the Live Oak Canyon fault, Claremont fault, Loma Linda fault, Rialto-Colton fault, Beaumont Plain fault zone, San Gorgonio Pass fault, Garnet Hill fault, and South Branch san Andreas fault. The locations of these fault crossings along Project segments and location of towers relative to individual fault strands are discussed in Section D.9.1.2. Hazards from fault rupture are generally not as great where the proposed route crosses traces of potentially active faults, such as the Live Oak Canyon fault, Loma Linda fault, and Beaumont Plain fault, and where towers are not located near to the fault traces. In order to avoid tower damage and/or collapse, towers should be sited so as not to straddle or be placed immediately adjacent to fault traces. Fault crossings, where multiple feet of displacement are expected along active faults, Alquist-Priolo zoned faults, and County of Riverside County Fault Zone mapped faults are best crossed as overhead lines with towers placed well outside the fault zone to allow for the flex in the conductor lines to absorb offset. Mitigation Measure G-1a (Conduct fault evaluation study and minimize project structures within active fault zones) would ensure that Project towers are not placed on or immediately adjacent to active faults and that the length of transmission line within and crossing the fault is minimized.

Mitigation Measures for Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

G-1a **Conduct fault evaluation study and minimize project structures within active fault zones.** Prior to final Project design, SCE shall perform fault evaluation studies to confirm the location of mapped traces of active and potentially active faults crossed by the project route or other project structures, as described in Section D.9.1.2 for each project segment. For crossings of active faults, the project design shall not locate towers or other project structures on the traces of active faults; and additionally, all other project components shall be placed as far as feasible outside the areas of mapped fault traces.

SCE shall provide CPUC and BLM a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of project construction.

Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

Strong to severe groundshaking should be expected in the event of an earthquake on the faults near the project, with estimated PGAs ranging from 0.8 to 1.2 g along the entire route. The project would also be subject to groundshaking from a large earthquake on any of the major faults in the region. While the shaking would be less severe from an earthquake that originates farther from the route, the effects, particularly on the ridgelines and hills, could be damaging to project structures. It is likely that project components would be subjected to at least one moderate or larger earthquake occurring close enough to produce groundshaking along this segment.

Seismically induced slope failures such as landslides could occur in the event of a large earthquake along portions of the project. Portions of Segments 1 through 4 are located in the landslide-prone San Timoteo Formation along hillsides or ridgelines with moderate to steep slopes which would be particularly susceptible to this type of ground failure. Hillside areas underlain by San Timoteo Formation have a high possibility of seismic-induced ground failure in the form of landsliding or ground-cracking resulting in damage to project structures. The steep slopes north of Vista Grande Way (in Grand Terrace and Colton) have been shown to be unstable during recent construction, according to the City of Grand Terrace.

Portions of Segments 5 and 6 are located in gentle to moderate hills that are traversed by active faults in close proximity to the project alignment; groundshaking or fault rupture from an earthquake on these faults could be destabilize the hill slopes. Implementation of Mitigation Measure G-2a (Conduct geological surveys for landslides and unstable slopes) would reduce the potential for earthquake-induced slope instability to damage project structures.

Although portions of the project route are mapped as having moderate liquefaction susceptibility by Riverside County, anticipated depths to groundwater of greater than 200 to 300 feet reduces the liquefaction potential of these areas to very low. Portions of the project alignment underlain by older consolidated and semi-consolidated units such as Pleistocene nonmarine sedimentary deposits and Plio-Pleistocene San Timoteo Formation have no or very low liquefaction potential. Therefore there is no potential for project components to be damaged by liquefaction and liquefaction-related phenomena and no mitigation is needed.

Mitigation Measure for Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

G-2a **Conduct geotechnical surveys for landslides and unstable slopes.** SCE shall conduct design-level geotechnical surveys for the project that include slope stability surveys in areas where project components are located on hills or hill tops. These surveys will acquire data that will allow identification of specific areas with the potential for unstable slopes, landslides, earth flows, and debris flows along the approved transmission line route and along other project components crossing these hills such as access and spur roads. The investigations shall include an evaluation of subsurface conditions, identification of potential landslide hazards, and provide potential modifications to the project design to avoid areas of unstable slopes and landslide hazards, such as modification of tower locations. Where the geotechnical surveys determine that landslide hazard areas cannot be avoided, best engineering design and construction measures shall be incorporated into the project designs to prevent potential damage to project facilities.

SCE shall provide CPUC and BLM a copy of the geotechnical survey report for review, at least 60 days before construction. In addition, SCE shall submit a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of the project.

Impact G-3: Erosion could be triggered or accelerated due to construction activities

Excavation and grading for tower foundations, foundations for new equipment at substations, underground conduits and vaults, work areas, access roads, and spur roads could loosen soil and accelerate erosion. Current regulations would require that the project obtain under Clean Water Act regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity as construction would disturb a surface area greater than 1 acre. Additionally, compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP). (See Section D.19, Water Resources and Hydrology, which discusses the SWPPP at length.) The SWPPP would require development and implementation of BMPs to identify and control erosion, which would reduce the potential for construction to trigger erosion.

As noted in Section B.6 (Applicant Proposed Measures), APM BIO-1 would require preparation of a revegetation plan for areas subject to temporary project impacts and APM HYDRO-3 would require development of and adherence to erosion-control and hazardous material plans during construction. However, these APMs have been superseded by more detailed mitigation measures: Mitigation Measure WR-2a (Implement an Erosion Control Plan and demonstrate compliance with water quality permits) and Mitigation Measure VEG-1d (Restore or revegetate temporary disturbance areas). These measures would ensure that erosion is sufficiently controlled.

Mitigation Measures for Impact G-3: Erosion could be triggered or accelerated due to construction activities

WR-2a **Implement an Erosion Control Plan and demonstrate compliance with water quality permits.** (Full text included in Section D.19)

VEG-1d **Restore or revegetate temporary disturbance areas.** (Full text included in Section D.4)

Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

The landslide-prone San Timoteo Formation underlies the San Timoteo Badlands along Segments 1 through 3 and small areas of Segment 4 through the hills where it traverses along the southern edge of the San Bernardino Mountains. Excavation and grading for tower foundations and work areas, and grading for new and modified access and spur roads could result in slope instability in these areas. Slope instability could include landslides, earthflows, soil creep, or debris flows. Slope instability has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components. As defined in the discussion of Impact G-2 (Project structures could be damaged by seismically induced groundshaking), evidence of unstable slopes has been noted north of Vista Grande Way in Colton and Grand Terrace. Mitigation Measure G-2a (Conduct geotechnical surveys for landslides and unstable slopes) would reduce the potential impacts for construction to trigger slope instability by ensuring that SCE performs appropriate geotechnical surveys for landslides and unstable slopes.

Mitigation Measure for Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

G-2a **Conduct geotechnical surveys for landslides and unstable slopes.** (Full text provided above under Impact G-2)

Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

Expansion potential for the soils along the project alignment ranges from low to high; local soils (the Ramona-Placentia-Greenfield-Linne soil association) along Segments 1, 3, 4, 5 have a low to high potential for expansion and soils, the remainder of the soils along the project alignment have low and low to moderate potential for expansion as presented in Table D.9-2. Soils that exhibit shrink-swell behavior are clay-rich and react to changes in moisture content by expanding or contracting. Some of the natural soil types identified along the project may have moderate to high clay contents and many have moderate to high shrink-swell potential. Expansive soils can cause problems to structures. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to structures and equipment. Soils along the project segments have a potential to corrode steel ranging from low to high and a potential to corrode concrete from low to moderate. In areas where corrosive subsurface soils exist along the project route, the corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures. Application of standard design and construction practices and implementation of Mitigation Measure G-5a (Assess soil characteristics to aid in appropriate foundation design) would reduce the potential impact from unsuitable soils.

Mitigation Measure for Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

G-5a **Assess soil characteristics to aid in appropriate foundation design.** The design-level geotechnical studies conducted for the project shall include soils analyses to identify the presence, if any, of potentially detrimental soil chemicals, such as chlorides and sulfates, and soils with moderate to high shrink/swell or expansion potential. If corrosive soils are identified, appropriate design measures for protection of reinforcement, concrete, and metal structural components against corrosion shall be utilized, such as use of corrosion-resistant materials and coatings, increased thickness of project components exposed to potentially corrosive conditions, and use of passive and/or active catholic protection systems. If expansive soils are identified, the project design shall be modified to include appropriate design features, such as including excavation of potentially expansive or during construction and replacement with engineered backfill, ground-treatment processes, and redirection of surface water and drainage away from expansive foundation soils.

SCE shall provide CPUC and BLM a copy of the design-level geotechnical studies for review at least 60 days before the start of construction. In addition, SCE shall submit a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of the project.

D.9.3.4 Impacts of Connected Actions

Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

Desert Center Area. During construction of solar projects in the Desert Center area, regional seismic hazards could expose site workers to seismic hazards, including being struck by project infrastructure that may move as a result of seismic shaking or by being present in an unstable indoor area; however, seismic events are infrequent. Implementation of design characteristics that comply with the CBC and other strict regulations for standard engineering design would reduce seismic effects by ensuring that occupied buildings are constructed safely to withstand seismic shaking. For example, the Palen Solar Power Project (CEC, 2010) would implement Condition of Certification GEO-1 and Facility Design Conditions of Certification GEN-1, GEN-5 and CIVIL-1. Compliance with these requirements would ensure the project is built to current seismic standards and potential impacts would be mitigated to current standards of engineering practice. In addition, the EDF Desert Harvest Project (BLM, 2012) includes MM PHS-5 (Emergency Response Plan), which would ensure that emergency response is organized and coordinated at the solar facility site during construction, including in the event of a seismic or geologic hazard. Other solar energy projects in the area would include design criteria to comply with earthquake safety requirements and, typically, include Emergency Response Plans.

Blythe Area. The entire Southern California region is subject to secondary effects from earthquakes. The closest active fault in the area is the Brawley Seismic Zone. As such, the solar projects likely would not be within a designated Alquist-Priolo Fault Zone, and there are no known active or potentially active faults underlying the area. Therefore, the potential for surface ground rupture and lurching or cracking of the ground surface is considered low.

Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

Liquefaction generally occurs in saturated or near-saturated soils at depths shallower than approximately 50 feet below grade. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Desert Center Area. The risk of liquefaction at solar facilities in this area would be low to moderate. Groundwater levels may fluctuate with precipitation, irrigation, drainage, and regional pumping from wells; however, based on levels recorded in wells found in the area, groundwater is estimated to be greater than 50 feet below ground surface. For example, the Palen Solar Power Project is located within an area with low to moderate level of liquefaction potential and, based on measured values in boreholes and wells near the this solar facility site, the estimated depth to groundwater is greater than 60 feet below existing grade. In addition, the typical medium dense to very dense nature of the coarse grain soils encountered indicates that there is no liquefaction potential at the. As a result, soil susceptibility to liquefaction during a seismic event is not considered likely in the Desert Center area.

Blythe Area. The closest active fault in the Blythe area is the Brawley Seismic Zone, more than 45 miles away. Therefore, solar projects in the Blythe area likely would not be within a designated Alquist-Priolo Fault Zone, as there are no known active or potentially active faults underlying the area. Severe ground-shaking along the Brawley Seismic Zone, Elmore Ranch, and the San Andreas faults could result in damage to site structures, including the solar panels, inverters/transformers, interior collection power lines, on-site substations, and O&M buildings, as well as any associated gen-ties lines. Groundwater at a depth greater than 50 feet has been known to occur in the area. Due to the depth of groundwater, liquefaction and seismically induced settlement are unlikely. Potential effects to the solar facilities and associated structures related to ground shaking would be reduced through compliance with State and local regulations and standards and established engineering procedures. Structures would be designed in accordance with the County of Riverside Building Codes and the most recent CBC and IBC requirements (see Section D.9.2, Applicable Regulations, Plans, and Standards). As part of the development process for the solar projects, a final design level geotechnical report likely would be prepared and recommendations outlined to ensure safety of structures.

Impact G-3: Erosion could be triggered or accelerated due to construction activities

Solar project construction would require ground-disturbing activities. Examples include site grading, solar panel installation, O&M building construction, installation of the gen-tie lines, and construction of access roads. These activities can lead to increased soil erosion, soil compaction, loss of soil productivity, and disturbance of soils crucial for supporting vegetation. Activities that expose and disturb the soil leave soil particles vulnerable to detachment by wind and water and can lead to the loss of topsoil and increased sediment loading to waterways during rain events. The magnitude, extent, and duration of those impacts depend on factors such as proximity of the construction site to waterways or water courses, soil type, and the method, duration, and time of year of soil-disturbing construction activities. Prolonged periods of precipitation, or high intensity and short duration runoff events coupled with earth disturbance activities can result in on-site erosion. In addition, high winds in areas of disturbed ground can result in wind borne dust that adversely affects air quality.

With proper implementation of control measures, soil erosion impacts can be reduced or avoided. Such measures typically are included a project's Storm Water Pollution Prevention Plan (SWPPP), as required by the NPDES. Examples include wetting roads and disturbed surfaces in active construction and laydown areas; controlling speed on unpaved surfaces; placing gravel at project site entrances; using straw bales, silt fences, and earthen berms to control runoff; restoring native plant communities through natural revegetation, seeding, and transplanting; and applying soil bonding and weighting agents. During grading work, soil can be stabilized by maintaining sufficient water content through watering to make the soil resistant to weathering and erosion by wind and water. Grading in planned phases, rather that disturbing an entire site at once, also reduces impacts. In addition, measures such as Proposed Project Mitigation Measures WR-2a (Implement an Erosion Control Plan and demonstrate compliance with water quality permits), and VEG-1d (Restore or revegetate temporary disturbance areas) are examples of mitigation measures that can help reduce erosion effects.

Desert Center Area. Old or inactive dune deposits exist throughout the Desert Center area. Because of limited sand sources, the potential for wind-driven sand erosion is low. Disturbance to existing soil crusts and/or desert pavement at a solar facility site could result in a substantial increase in on-site wind- and waterborne soil erosion. However, these potential impacts would be minimized by a combination of project design features. Compliance with regulatory requirements related to fugitive dust control, and standard SWPPP BMPs (see above), ensure that erosion due to construction activities is minimized. For example, the EDF Desert Harvest Solar Project would implement Mitigation Measures MM AIR-1 (Fugitive Dust Control Plan), MM AIR-2 (Fugitive Dust Control of Unpaved Roads), and MM WAT-4 (Surface Water Protection Plan and Drainage Design Specifications) (BLM, 2012). The Palen Solar Power Project also has similar requirements in compliance with air quality and water regulations. Other solar projects in the area would be subject to similar impact control measures.

Blythe Area. Solar projects in the Blythe area would be required to implement fugitive dust control measures in accordance with MDAQMD Rule 403. Compliance with this regulatory requirement and standard SWPPP BMPs would help ensure that erosion due to project construction activities is minimized.

Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

Common to All Areas. All areas with connected solar project have extensive areas of flat to gently sloping land created alluvial fans across the valley floor. Grading for projects is not expected to create areas of slope instability or trigger or accelerate landslides. Project design parameters, compliance with mandated regulatory requirements, and implementation of standard SWPPP BMPs (such as wetting roads and disturbed surfaces in active construction and laydown areas, controlling speed on unpaved surfaces, placing gravel at project site entrances, using straw bales and other means to control runoff, restoring native plant communities, and applying soil bonding and weighting agents) would ensure that project construction does not trigger landslides.

Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

Desert Center Area. The Desert Center area is generally surfaced with up to 2 feet of unconsolidated soils resulting from desiccation and/or wind deposition. The soils below the surficial materials are generally medium dense to very dense poorly graded sand with varying amounts of silt, silty sand, and clayey sand. Firm to very hard sandy clays are locally interbedded. The near surface soils are primarily granular with no to low swell potential; however, potentially expansive soils could occur. Loose dune sand also occurs. Ground shaking, compaction, expansive soils, and corrosive soils represent the main potential geologic hazards in the area.

These potential hazards could be effectively mitigated incorporating recommendations contained project-specific geotechnical evaluations, such as required for the Palen project under Condition of Certification GEO-1, which requires geologic hazards to be addressed in a design-level project geotechnical report. In addition, Conditions of Certification also mitigate these impacts. Similarly, the Desert Harvest project (BLM, 2012) would implement Condition of Certification GEO-1 (Design Plan), which requires project structures to be built in accordance with the design-basis recommendations in the project-specific geotechnical investigation report. Structure designs for these projects, as well as other solar projects in the area, must meet the requirements of all applicable federal, State, and county permits and building codes.

Application of standard design and construction practices and implementation of typical mitigation measures would help avoid damage to project structures as result of problematic soils.

Blythe Area. The Blythe area consists of extensive granular alluvial deposits (sand and gravel). Therefore, the potential for near-surface expansive soils to adversely affect proposed improvements at solar facilities in the area is considered low. Aeolian sand and active or plowed agricultural fields may conceal underlying cracks or fissures. Subsidence can occur as a result of new loads, such as new structures or other improvements, being located on some areas unless the underlying soils are appropriately prepared

Application of standard design and construction practices and implementation of typical mitigation measures such as Proposed Project Mitigation Measure G-5a (Assess soil characteristics to aid in appropriate foundation design) would reduce the potential impact from unsuitable soils.

D.9.4 Environmental Impacts of Project Alternatives

Three alternatives are considered in this section; all of these alternatives would be located within the existing WOD ROW. The No Action Alternative is evaluated in Section D.9.5. Alternatives are described in detail in Appendix 5 (Alternatives Screening Report) and are summarized in Section C.

Geology and soil resources within the ROW are described by segment in Section D.9.1.2 above; the description of the environmental setting would apply equally to the alternatives.

D.9.4.1 Tower Relocation Alternative

The Tower Relocation Alternative would locate certain transmission structures in Segments 4, 5, and 6 farther from existing homes than would be the case under the Proposed Project.

Five impacts related to geology and soils were identified for the Proposed Project. These impacts also would apply to the Tower Relocation Alternative, which overall would be the same as the Proposed Project, with the exception of the relocated transmission towers that are described above and in Appendix 5. The full text of all mitigation measures referenced in this section is presented in Section D.9.3.3, except where otherwise noted.

Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

Project facilities would be subject to hazards of surface fault rupture at crossings of active and potentially active faults. The project route crosses several active and potentially active faults.

The relocated structures would be located in the same seismically active area as the Proposed Project structures and would be subject to the same risk of damage by surface fault rupture. Implementation of Mitigation Measure G-1a (Conduct fault evaluation study and minimize project structures within active fault zones) would ensure that structures would not straddle or be placed immediately adjacent to fault traces.

Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

Strong to severe groundshaking should be expected in the event of an earthquake on the faults near the project, with estimated PGAs ranging from 0.8 to 1.2 g along the entire route. The project would also be subject to groundshaking from a large earthquake on any of the major faults in the region. While the shaking would be less severe from an earthquake that originates farther from the route, the effects, particularly on the ridgelines and hills, could be damaging to project structures. It is likely that project components would be subjected to at least one moderate or larger earthquake occurring close enough to produce groundshaking. Portions of Segments 5 and 6 are located in gentle to moderate hills that are traversed by active faults in close proximity to the project alignment; groundshaking or fault rupture from an earthquake on these faults could be destabilize the hill slopes.

Although portions of the project route are mapped as having moderate liquefaction susceptibility by Riverside County, anticipated depths to groundwater of greater than 200 to 300 feet reduces the liquefaction potential of these areas to very low. Therefore there is no potential for project components to be damaged by liquefaction and liquefaction-related phenomena.

The strong groundshaking that would potentially affect Proposed Project structures would also affect structures under the Tower Relocation Alternative. As discussed above under Impact G-1, several potentially active faults cross the ROW near the relocated towers. Implementation of Mitigation Measure G-2a (Conduct geological surveys for landslides and unstable slopes) would reduce the potential for earthquake-induced slope instability to damage project structures

Impact G-3: Erosion could be triggered or accelerated due to construction activities

Excavation and grading for tower foundations, foundations for new equipment at substations, underground conduits and vaults, work areas, access roads, and spur roads could loosen soil and accelerate erosion. Current regulations would require that the project obtain under Clean Water Act regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity as construction would disturb a surface area greater than 1 acre. Additionally, compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP) The SWPPP would require development and implementation of BMPs to identify and control erosion, which would reduce the potential for construction to trigger erosion.

Most of the structures that would be relocated in this alternative would be located on level ground, but several relocations would occur in the hills west of Cherry Valley Boulevard. The ground disturbance associated with the relocated structures would result in the same erosion potential as would occur with the Proposed Project towers, which would also be on slopes. Compliance existing regulations and with Mitigation Measure WR-2a (Implement an Erosion Control Plan and demonstrate compliance with water quality permits) and Mitigation Measure VEG-1d (Restore or revegetate temporary disturbance areas) would ensure that the potential adverse effects related to erosion under this alternative would be minor.

Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

The landslide-prone San Timoteo Formation underlies the San Timoteo Badlands along Segments 1 through 3 and small areas of Segment 4 through the hills where it traverses along the southern edge of the San Bernardino Mountains. Excavation and grading for tower foundations and work areas, and grading for new and modified access and spur roads could result in slope instability in these areas.

Few of the structures that would be relocated under this alternative would be located on slopes with landslide risks. The few structures on hillslopes would have the same risk as the Proposed Project, and the risk of failure would be reduced with implementation of Mitigation Measure G-2a (Conduct geotechnical surveys for landslides and unstable slopes). With implementation of mitigation, the adverse effects related to project-induced slope instability would be minor.

Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

Expansion potential for the soils along the project alignment ranges from low to high. Local soils (the Ramona-Placentia-Greenfield-Linne soil association) along Segments 1, 3, 4, 5 have a low to high potential for expansion and soils. Soils that exhibit shrink-swell behavior are clay-rich and react to changes in moisture content by expanding or contracting. Some of the natural soil types identified along the project may have moderate to high clay contents and many have moderate to high shrink-swell potential. Expansive soils can cause problems to structures. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to structures and equipment. Soils along the project segments have a potential to corrode steel ranging from low to high and a potential to corrode concrete from low to moderate. In areas where corrosive subsurface soils exist along the project route, the corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures.

The relocated towers in Segment 4 and 5 would be located on the same soil type as the Proposed Project structures that they would be replacing, which has a low to high shrink/swell potential, a low to moderate risk of corrosion for concrete, and a low to high risk of corrosion for uncoated steel. The relocated towers in Segment 6 would be located on the same soil type as the Proposed Project structures that they would be replacing, which has a low shrink/swell potential, a low risk of corrosion for concrete, and a high risk of corrosion for uncoated steel. Application of standard design and construction practices and implementation of Mitigation Measure G-5a (Assess soil characteristics to aid in appropriate foundation design) would reduce the adverse effect from unsuitable soils.

D.9.4.2 Iowa Street 66 kV Underground Alternative

The Iowa Street 66 kV Underground Alternative would place a 1,600-foot segment of subtransmission line underground, rather than overhead.

Five impacts were identified under the Proposed Project for geology and soils. These impacts also would apply to the Iowa Street 66 kV Underground Alternative, which overall would be the same as the Proposed Project, with the exception of the underground portion of the subtransmission line that is described above and in Appendix 5. The full text of all mitigation measures referenced in this section is presented in Section D.9.3.3, except where otherwise noted.

Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

Project facilities would be subject to hazards of surface fault rupture at crossings of active and potentially active faults. While the project route crosses several active and potentially active faults, no active or potentially active faults are located along or near the underground subtransmission line portion of this alternative.

Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

The project would be subject to groundshaking from a large earthquake on any of the major faults in the region. However, no active or potentially active faults are located along or near the underground subtransmission line portion of this alternative.

Like in the Proposed Project, the lack of shallow groundwater results in a low potential for liquefaction. The underground portion of the subtransmission line would be located on mostly level ground and would not be subject to damage from seismically induced slope failures such as landslides.

Impact G-3: Erosion could be triggered or accelerated due to construction activities

Excavation and grading could loosen soil and accelerate erosion. Current regulations would require that the project obtain under Clean Water Act regulations a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity as construction would disturb a surface area greater than 1 acre. Additionally, compliance with the NPDES would require that the applicant submit a Storm Water Pollution Prevention Plan (SWPPP) The SWPPP would require development and implementation of BMPs to identify and control erosion, which would reduce the potential for construction to trigger erosion.

The underground portion of the subtransmission line under this alternative would be located on level ground, and the ground disturbance associated with the underground line would not result in substantial erosion.

Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

As described above, the underground subtransmission line in this alternative would be located on level ground. Therefore, the ground disturbance associated with the underground line would not trigger slope instability.

Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

The soil distribution within 1 mile of the project ROW is shown on Figure D.9-2, Soil Distribution. Soils that exhibit shrink-swell behavior are clay-rich and react to changes in moisture content by expanding or contracting. Some of the natural soil types identified along the project may have moderate to high clay contents and many have moderate to high shrink-swell potential. Expansive soils can cause problems to structures. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to structures and equipment. Soils along the project segments have a potential to corrode steel ranging from low to high and a potential to corrode concrete from low to moderate. In areas where corrosive subsurface soils exist along the project route, the corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures.

The underground subtransmission line would be located on the same soil type as the Proposed Project structures that it would be replacing, which has a low to high shrink/swell potential, a low to moderate risk of corrosion for concrete, and a low to high risk of corrosion for uncoated steel. Underground conduits are protected by concrete. Underground construction would require assessing the soil to identify problematic soils. Typical trenching and installation of conduits for the underground line would use backfill that would ensure that soil-related problems would not occur.

D.9.4.3 Phased Build Alternative

The Phased Build Alternative would retain existing double-circuit 220 kV transmission structures to the extent feasible, remove single-circuit structures, add new double-circuit 220 kV structures, and string all structures with higher-capacity conductors.

Five impacts related to geology and soils were identified for the Proposed Project. These impacts also would apply to the Phased Build Alternative, which would be located in the same corridor as the Proposed Project and would involve similar although less intense construction activities. The full text of all mitigation measures referenced in this section is presented in Section D.9.3.3, except where otherwise noted.

Impact G-1: Project structures could be damaged by surface fault rupture at crossings of active and potentially active faults

Project facilities would be subject to hazards of surface fault rupture at crossings of active and potentially active faults. The project route crosses several active and potentially active faults including: the Live Oak Canyon fault, Claremont fault, Loma Linda fault, Rialto-Colton fault, Beaumont Plain fault zone, San Gorgonio Pass fault, Garnet Hill fault, and South Branch san Andreas fault. The locations of these fault crossings along Project segments and location of towers relative to individual fault strands are discussed in Section D.9.1.2. Hazards from fault rupture are generally not as great where the proposed route crosses traces of potentially active faults, such as the Live Oak Canyon fault, Loma Linda fault, and Beaumont Plain fault, and where towers are not located near to the fault traces. In order to avoid tower damage and/or collapse, towers should be sited so as not to straddle or be placed immediately adjacent to fault traces. Fault crossings, where multiple feet of displacement are expected along active faults, Alquist-Priolo zoned faults, and County of Riverside County Fault Zone mapped faults are best crossed as overhead lines with towers placed well outside the fault zone to allow for the flex in the conductor lines to absorb offset.

High-capacity conductors would be installed on a combination of new and existing 220 kV structures within the existing ROW. Like the Proposed Project towers, several of the new and existing structures would be located near potentially active faults. The structures in this alternative would be located in the same seismically active area as the Proposed Project structures and would be subject to the same risk of damage by surface fault rupture. The precise location of all surface fault traces within the project ROW is unknown. In order to avoid damage to structures by surface fault rupture, the same mitigation that would be required for the Proposed Project would also be required for this alternative. Implementation of Mitigation Measure G-1a (Conduct fault evaluation study and minimize project structures within active fault zones) would ensure that structures would not straddle or be placed immediately adjacent to fault traces.

Impact G-2: Project structures could be damaged by seismically induced groundshaking and/or ground failures, such as landslides and liquefaction-related phenomena, exposing people or structures to hazards

Strong to severe groundshaking should be expected in the event of an earthquake on the faults near the project, with estimated PGAs ranging from 0.8 to 1.2 g along the entire route. The project would also be subject to groundshaking from a large earthquake on any of the major faults in the region. While the shaking would be less severe from an earthquake that originates farther from the route, the effects, particularly on the ridgelines and hills, could be damaging to project structures. It is likely that project components would be subjected to at least one moderate or larger earthquake occurring close enough to produce groundshaking.

Seismically induced slope failures such as landslides could occur in the event of a large earthquake along portions of the project. Portions of Segments 1 through 4 are located in the landslide-prone San Timoteo Formation along hillsides or ridgelines with moderate to steep slopes which would be particularly susceptible to this type of ground failure. Hillside areas underlain by San Timoteo Formation have a high possibility of seismic-induced ground failure in the form of landsliding or ground-cracking resulting in damage to project structures. The steep slopes north of Vista Grande Way (in Grand Terrace and Colton) have been shown to be unstable during recent construction, according to the City of Grand Terrace.

Portions of Segments 5 and 6 are located in gentle to moderate hills that are traversed by active faults in close proximity to the project alignment; groundshaking or fault rupture from an earthquake on these faults could be destabilize the hill slopes. Implementation of Mitigation Measure G-2a (Conduct geological surveys for landslides and unstable slopes) would reduce the potential for earthquake-induced slope instability to damage project structures.

Although portions of the project route are mapped as having moderate liquefaction susceptibility by Riverside County, anticipated depths to groundwater of greater than 200 to 300 feet reduces the liquefaction potential of these areas to very low. Portions of the project alignment underlain by older consolidated and semi-consolidated units such as Pleistocene nonmarine sedimentary deposits and Plio-Pleistocene San Timoteo Formation have no or very low liquefaction potential. Therefore there is no potential for project components to be damaged by liquefaction and liquefaction-related phenomena and no mitigation is needed.

The same strong groundshaking that would potentially affect Proposed Project structures would also affect structures under the Phased Build Alternative. Several potentially active faults cross the ROW near the new and existing structures. In the event of an earthquake along the faults near the project, peak ground acceleration would range from 0.8 to 1.2 g. The risk of damage to project structures from strong groundshaking in this alternative would be the same as in the Proposed Project. This adverse effect would be minor because transmission structures are engineered to withstand strong groundshaking. The depth to groundwater is the same in this alternative as for the Proposed Project, and is generally greater than 200 feet. Like in the Proposed Project, the lack of shallow groundwater results in a low potential for liquefaction. Therefore, the same as in the Proposed Project, structures in this alternative would not be subject to adverse effects due to liquefaction. The same as in the Proposed Project, structures associated with the Phased Build Alternative that are located on steep slopes within Grand Terrace and Colton, north of Vista Grande Way, and the San Timoteo Formation would remain susceptible to seismically induced slope failure. The severity of this adverse effect would be reduced through implementation of Mitigation Measure G-2a (Conduct geotechnical surveys for landslides and unstable slopes).

Impact G-3: Erosion could be triggered or accelerated due to construction activities

Excavation and grading for tower foundations, foundations for new equipment at substations, underground conduits and vaults, work areas, access roads, and spur roads could loosen soil and accelerate erosion.

The Phased Build Alternative would reduce the amount of ground disturbance compared to the Proposed Project, and consequently would reduce the potential to cause or accelerate erosion and siltation. The ground disturbance associated with the new 220 kV structures would not result in more substantial erosion than would occur with the Proposed Project towers. The same as for the Proposed Project, excavation and grading for new tower foundations, foundations for new equipment at substations, underground conduits and vaults, work areas, access roads, and spur roads could loosen soil and accelerate erosion.

As under the Proposed Project, erosion would be greatest for activities that take place on steep slopes. As a component of both the Proposed Project and this alternative, SCE would have to obtain a National Pollution Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity. This permit requires the development of a Storm Water Pollution Prevention Plan (SWPPP), which requires development and implementation of BMPs to identify and control erosion. In addition to compliance with existing regulation, the potential for this alternative to result in accelerated erosion would be reduced through implementation of Mitigation Measure WR-2a (Implement an Erosion Control Plan and demonstrate compliance with water quality permits). The full text of this mitigation measure is presented in the analysis for Water Resources and Hydrology in Section D.19.3.3. Compliance with existing regulations and implementation of the mitigation would ensure that the potential adverse effects related to erosion under this alternative would be minor.

Impact G-4: Slope instability, such as landslides, could be triggered or accelerated due to construction activities

Thee landslide-prone San Timoteo Formation underlies the San Timoteo Badlands along Segments 1 through 3 and small areas of Segment 4 through the hills where it traverses along the southern edge of the San Bernardino Mountains. Excavation and grading for tower foundations and work areas, and grading for new and modified access and spur roads could result in slope instability in these areas. Slope instability could include landslides, earthflows, soil creep, or debris flows. Slope instability has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components.

The ground disturbance associated with the new 220 kV structures would not result in a greater potential to trigger slope instability than would occur with the Proposed Project towers, which would be located on similar topography. The landslide-prone areas that are crossed by both the Proposed Project and this are the same. It is unlikely that ground disturbance in this alternative would result in slope instability greater than that of the Proposed Project. Mitigation Measure G-2a (Conduct geotechnical surveys for landslides and unstable slopes) would reduce the adverse effects related to project-induced slope instability under this alternative. With implementation of mitigation, the adverse effects related to project-induced slope instability would be minor.

Impact G-5: Project structures could be damaged by problematic soils exposing people or structures to hazards

Expansion potential for the soils along the project alignment ranges from low to high; local soils (the Ramona-Placentia-Greenfield-Linne soil association) along Segments 1, 3, 4, 5 have a low to high potential for expansion and soils, the remainder of the soils along the project alignment have low and low to moderate potential for expansion as presented in Table D.9-2. Soils that exhibit shrink-swell behavior are clay-rich and react to changes in moisture content by expanding or contracting. Some of the natural soil types identified along the project may have moderate to high clay contents and many have moderate to high shrink-swell potential. Expansive soils can cause problems to structures. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to structures and equipment. Soils along the project segments have a potential to corrode steel ranging from low to high and a potential to corrode concrete from low to moderate. In areas where corrosive subsurface soils exist along the project route, the corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures.

High-capacity conductors would be installed on a combination of new and existing 220 kV structures within the existing ROW. Therefore, structures under this alternative would be exposed to the same problematic soils that would affect the Proposed Project structures, as described in Section D.9.3.3. The Phased Build Alternative would reduce the amount of construction activity and the number of new tower foundations compared to the Proposed Project, and consequently would reduce the exposure to problematic soils. Application of standard design and construction practices and implementation of Mitigation Measure G-5a (Assess soil characteristics to aid in appropriate foundation design) would reduce the adverse effect from unsuitable soils.

D.9.5 Environmental Impacts of No Action Alternative

D.9.5.1 No Action Alternative Option 1

No Action Alternative Option 1 is described in Section C.6.3.1. It would consist of a new 500 kV circuit, primarily following the Devers-Valley transmission corridor and extending 26 miles between Devers Substation. It would also require a new 40-acre substation south of Beaumont, and 4 new 220 kV circuits extending 7 miles from the new Beaumont Substation to El Casco Substation, primarily following the existing El Casco 115 kV ROW. The remainder of the No Action Alternative, from El Casco Substation to the San Bernardino and Vista Substations, would be identical to the Proposed Project. Information on environmental resources and project impacts is derived from the Devers–Palo Verde 500 kV No. 2 Project EIR/EIS (CPUC and BLM, 2006) and the El Casco System Project Draft EIR (CPUC, 2007); which include nearly all of the No Action alignment.

Devers to Beaumont Substation. Between Devers and Beaumont, the 500 kV ROW crosses recent alluvium (unconsolidated alluvial deposits), nonmarine sedimentary deposits (conglomerate, sandstone, clay, siltstone, and shale), and granitic rock. Only the granitic rock presents difficult excavation characteristics. Most of the route does not cross areas identified as existing landslide; however unmapped landslides and areas of localized slope instability may be encountered in the mountains and foothills. Active and potentially active faults intersect the route. Soils vary from those formed in alluvial fans and sand (including desert pavement and desert varnish), which can be gravelly and sandy, to soils formed in alluvium weathered from granitic rocks and material in sandstone and shale. Generally, liquefaction is not considered a potential hazard due to the generally deep water table along the ROW. A few miles of alluvial sediments in the San Jacinto Valley (MP 13-MP 15) may be susceptible. As well, during storms or a wet season, the water table may rise and section of the route near washes and in unconsolidated sediments may become moderately susceptible to liquefaction during a strong earthquake. Portions of the route on moderate to steep slopes could be damaged by landslides, rock avalanches, and rockfalls. Impacts from geologic hazards and adverse soil conditions can be address by such measures as requiring geotechnical surveys for landslides and slope stability, minimizing structures in fault zones, minimizing ground surface disturbance, and requiring runoff and erosion control. The Devers to Beaumont Substation alignment would follow the existing Devers to Valley alignment. In the analysis of the Devers to Valley alignment in the DPV2 EIR/EIS, all impacts to geological resources were less than significant with mitigation.

Beaumont Substation. The substation site is not on any known fault traces, but is south of the San Andreas fault zone and east of the San Jacinto fault zone, both of which are active. Because of its position relative to surrounding uplands, soils are primarily alluvial in origin. To minimize geology and soils impacts, measures such as those identified above for the 500 kV alignment would be required.

Beaumont to El Casco Substation. Between Beaumont and El Casco, the alignment would cross a number of potentially active faults. The geology along the 220 kV segment consists primarily of recent alluvium and the San Timoteo Formation, which is gently to moderately sloping hills and is landslide-prone. Areas of potential liquefaction may occur in the alluvial sediments along the creek. As with the 500 kV alignment, measures to minimize impacts would include geotechnical surveys to inform foundation design and structure siting, minimization of ground surface disturbance, and requiring runoff and erosion control.

D.9.5.2 No Action Alternative Option 2

No Action Alternative Option 2 would require the construction of over 40 miles of new 500 kV transmission line, following the existing Valley-Serrano 500 kV line. The alternative is described in Section C.6.3.2, and illustrated on Figure C-6b.

Geologic formations along the corridor include alluvium in the Perris Valley and the area surrounding Temescal Wash, mudstone and claystone in the foothills surrounding Steele Peak and in the Cleveland National Forest (CNF), intrusive igneous rock near Steele Peak, volcanic rock in the foothills surrounding Estelle Mountain and in portions of the CNF, and sandstone and mudstone west of MP 30. In the eastern portion of this alternative, the route passes through sandy loam, rocky loam, and clay. The clay soils present a geologic hazard due to their expansive properties. The foothills surrounding Steele Peak and Estelle Mountain contain mostly rocky loam with a severe erosion potential. Unweathered intrusive igneous rock near Steele Peak may require blasting during construction. The CNF portion of the route contains mostly fine sandy loam, which also has a severe potential for erosion. To the west of the CNF, the route passes through sandy loam, clay loam, and rocky outcrops, all of which are classified as having a severe erosion potential.

There are no active or historic faults within or near the corridor east of MP 20. At approximately MP 21.2, just west of the Temescal Wash, the route crosses two adjacent Earthquake Fault Zones of Required Investigation, the Corona South and Lake Matthews fault zones. These fault zones of required investigation are within the more broadly defined Elsinore Fault Zone. This area is also subject to liquefaction. The Serrano Substation at MP 40.4 is located just south of the Peralta Hills Fault. The corridor passes through several mapped landslide hazard zones in the Peralta Hills, northwest of MP 32. In addition, potential unmapped landslide hazards may exist along the route where it passes through steep terrain in the foothills surrounding Steele Peak and Estelle Mountain and in the CNF. Impacts from geologic hazards and adverse soil conditions can be addressed by such measures as requiring geotechnical surveys for landslides and slope stability, minimizing structures in fault zones, minimizing ground surface disturbance, and requiring runoff and erosion control.

D.9.6 Mitigation Monitoring, Compliance, and Reporting

Table D.9-5 presents the mitigation monitoring, compliance, and reporting actions for geology and soils.

Table D.9-5. Mitigation Monitoring Program – Geology and Soils

MITIGATION MEASURE	**G-1a: Conduct fault evaluation study and minimize project structures within active fault zones.** Prior to final Project design, SCE shall perform fault evaluation studies to confirm the location of mapped traces of active and potentially active faults crossed by the project route or other project structures, as described in Section D.9.1.2 for each project segment. For crossings of active faults, the project design shall not locate towers or other project structures on the traces of active faults; and additionally, all other project components shall be placed as far as feasible outside the areas of mapped fault traces. SCE shall provide CPUC and BLM a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of project construction.
Location	Construction in vicinity of faults.
Monitoring / Reporting Action	CPUC/BLM monitor verifies receipt of documentation regarding foundations.
Effectiveness Criteria	Structures and foundations designed based on fault study and are located off of active fault traces and as far as feasible outside of areas with fault traces.
Responsible Agency	CPUC/BLM
Timing	At completion of foundation activities, letter provided.
MITIGATION MEASURE	**G-2a: Conduct geotechnical surveys for landslides and unstable slopes.** SCE shall conduct design-level geotechnical surveys for the project that include slope stability surveys in areas where project components are located on hills or hill tops. These surveys will acquire data that will allow identification of specific areas with the potential for unstable slopes, landslides, earth flows, and debris flows along the approved transmission line route and along other project components crossing these hills such as access and spur roads. The investigations shall include an evaluation of subsurface conditions, identification of potential landslide hazards, and provide potential modifications to the project design to avoid areas of unstable slopes and landslide hazards, such as modification of tower locations. Where the geotechnical surveys determine that landslide hazard areas cannot be avoided, best engineering design and construction measures shall be incorporated into the project designs to prevent potential damage to project facilities. SCE shall provide CPUC and BLM a copy of the geotechnical survey report for review, at least 60 days before construction. In addition, SCE shall submit a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of the project.
Location	Construction in vicinity of potential landslides and unstable slopes.
Monitoring / Reporting Action	Receive copy of geotechnical survey report and documentation letter.
Effectiveness Criteria	Study undertaken and followed; landslide and slope issues addressed
Responsible Agency	CPUC/BLM
Timing	60 days before construction report received; confirming letter following completion of foundation activities for each segment.

Table D.9-5. Mitigation Monitoring Program – Geology and Soils

MITIGATION MEASURE	**G-5a: Assess soil characteristics to aid in appropriate foundation design.** The design-level geotechnical studies conducted for the project shall include soils analyses to identify the presence, if any, of potentially detrimental soil chemicals, such as chlorides and sulfates, and soils with moderate to high shrink/swell or expansion potential. If corrosive soils are identified, appropriate design measures for protection of reinforcement, concrete, and metal structural components against corrosion shall be utilized, such as use of corrosion-resistant materials and coatings, increased thickness of project components exposed to potentially corrosive conditions, and use of passive and/or active catholic protection systems. If expansive soils are identified, the project design shall be modified to include appropriate design features, such as including excavation of potentially expansive or during construction and replacement with engineered backfill, ground-treatment processes, and redirection of surface water and drainage away from expansive foundation soils. SCE shall provide CPUC and BLM a copy of the design-level geotechnical studies for review at least 60 days before the start of construction. In addition, SCE shall submit a letter signed by a California registered geotechnical engineer following the completion date of all of the foundation activities for each segment. The letter will confirm that SCE followed the geotechnical report recommendations and the common engineering practice in southern California at the time of the project.
Location	Throughout project
Monitoring / Reporting Action	Geotechnical study report received; confirmation letter received
Effectiveness Criteria	Soils characterized and information used for appropriate foundation design.
Responsible Agency	CPUC/BLM
Timing	Geotechnical study report 60 days before the start of construction; confirming letter following completion of foundation activities for each segment.

D.9.7 References

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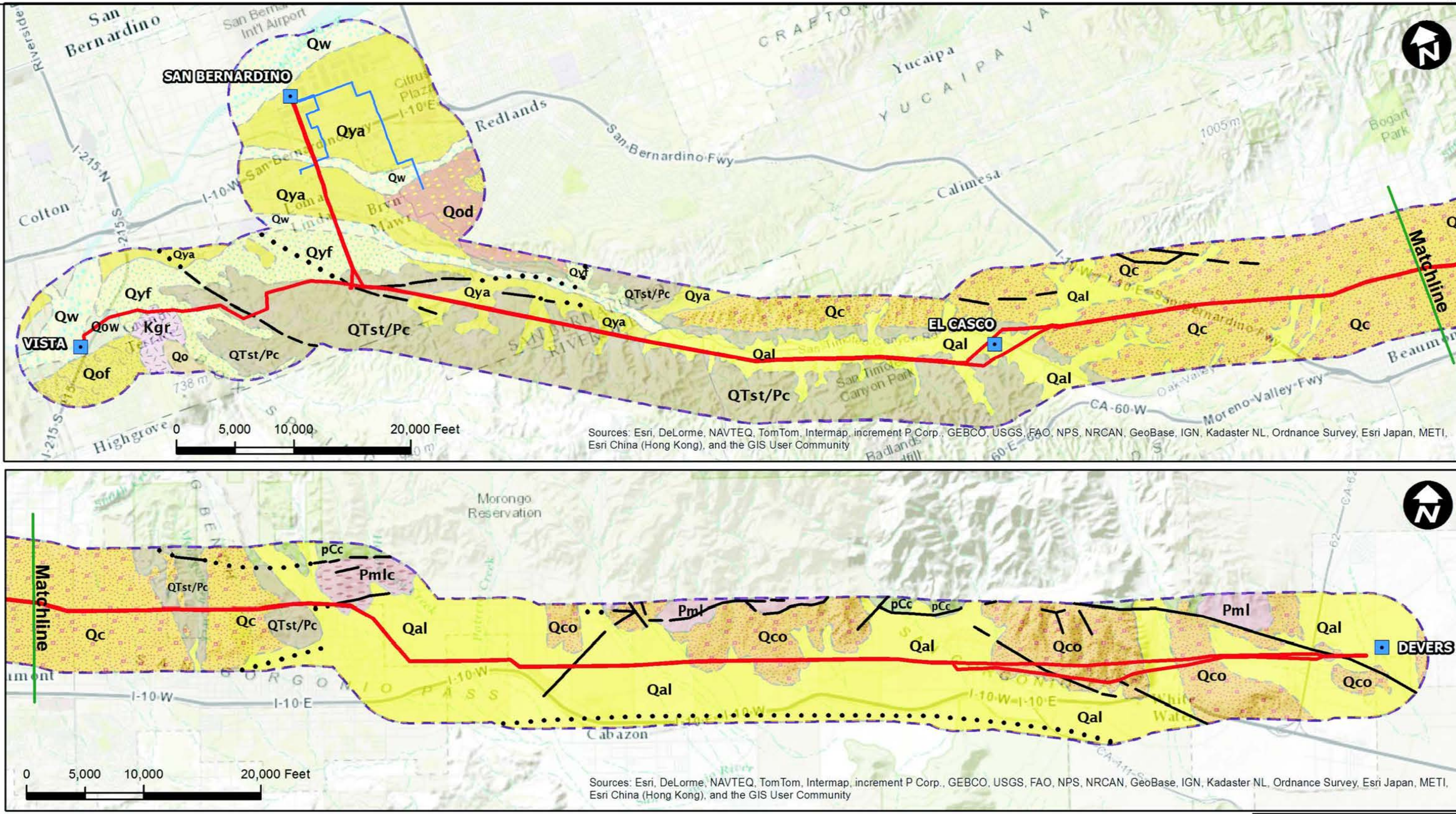

- Substations
- Proposed 220 kV Transmission Line
- Proposed 66 kV Subtransmission Lines
- 1-mile Buffer Zone

Geology

- Qw - Wash Deposits
- Qyf - Younger Fan Deposits
- Qal - Recent Alluvium
- Qow - Older Wash Deposits
- Qya - Younger Alluvium
- Qof - Older Fan Deposits
- Qo - Older Alluvium
- Qod - Well Dissected Alluvial Fans
- Qc - Pleistocene Nonmarine Sedimentary Rocks
- Qco - Plio-Pleistocene Nonmarine Sedimentary Rocks
- QTst/Pc - San Timoteo Formation
- Pmlc - Hathaway Formation
- Kgr Granitic Rocks
- pCc - San Gorgonio Igneous-Metamorphic Complex
- Faults, dashed where approximately located, dotted where concealed.

Geology Source: Modified from CGS, 1966, Geologic Map of California, Santa Ana Sheet, Scale 1:250,000; and CGS, 1986, Geologic Map of the San Bernardino Quadrangle, Scale 1:250,000.

West of Devers Upgrade Project

Figure D.9-1
Geologic Map

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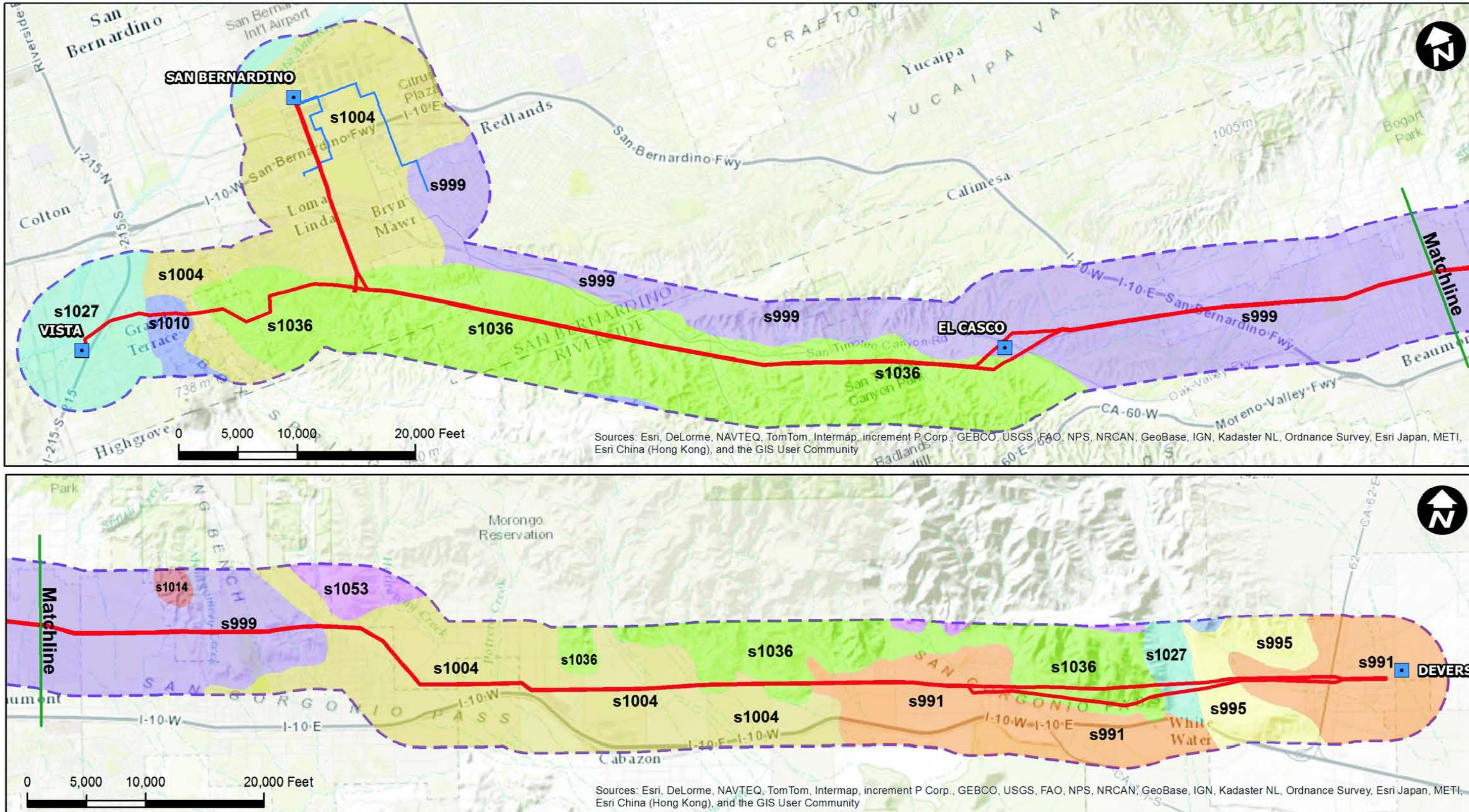

Substations

Proposed 220 kV Transmission Line

Proposed 66 kV Subtransmission Lines

1-mile Buffer Zone

Soil Associations

- s991 - Myoma-Carsitas-Carrizo
- s995 - Rock outcrop-Rillito-Beeline-Badland
- s999 - Ramona-Placentia-Linne-Greenfield
- s1004 - Ramona-Hanford-Greenfield-Gorgonio
- s1014 - Tollhouse-Rock outcrop-La Posta
- s1027 - Urban land-Tujunga-Soboba-Hanford
- s1036 - Xerorthents-Saugus-San Timoteo-Badland
- s1053 - Springdale-Rock outcrop-Etsel family
- s1126 - Tecopa-Rock outcrop-Lithic Torriorthents
- s1010 - Sesame-Rock outcrop-Cieneba

Soil Data Source: U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS), 2006. State Soil Survey Geographic (STATSGO) database, California data.

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Figure D.9-2

Soil Distribution

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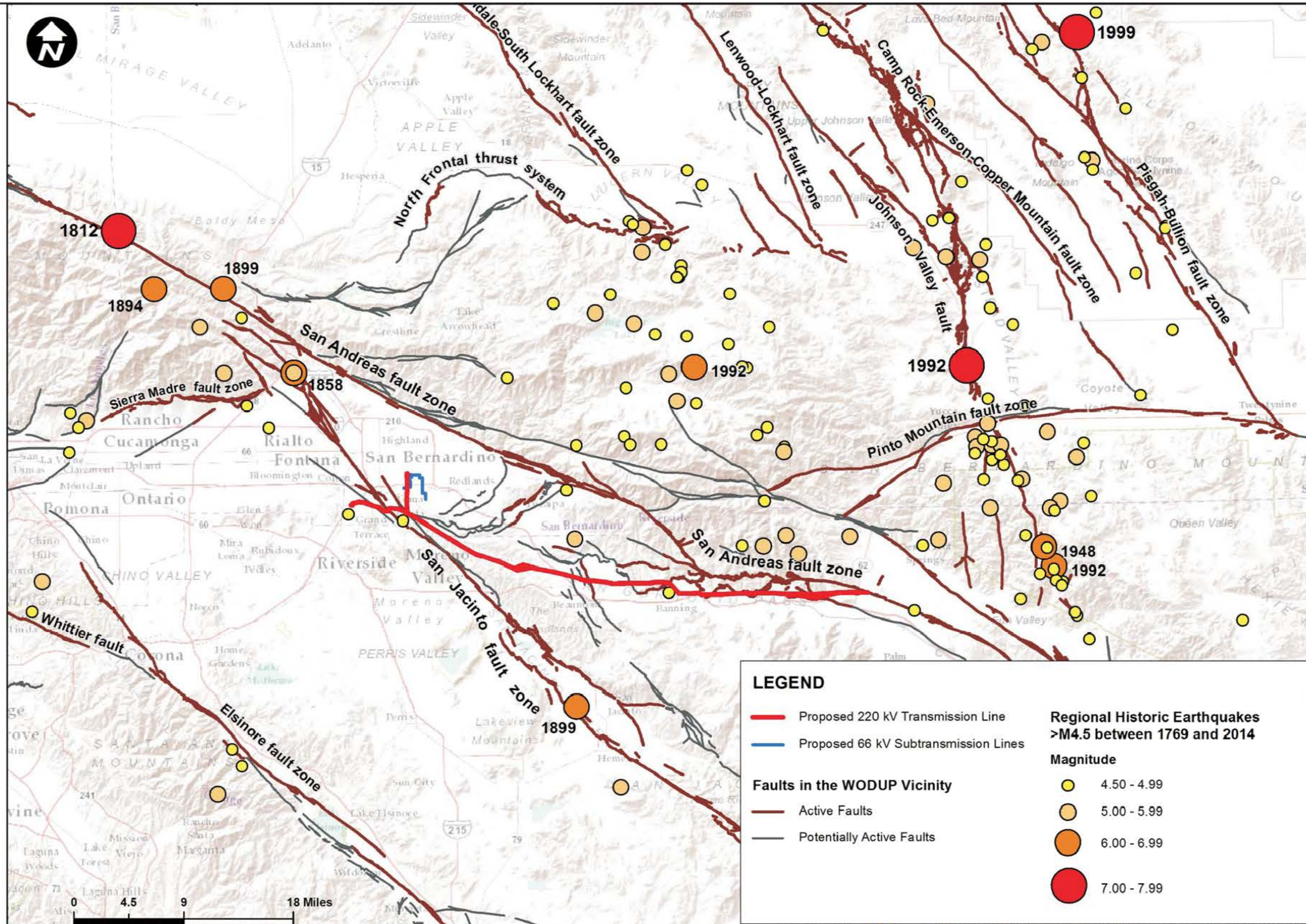

Data Sources: Faults - U.S.G.S. and C.G.S., 2010, Quaternary fault and fold database for the United States; Earthquakes - ANSS (Advanced National Seismic System) Catalog at http://quake.geo.berkeley.edu/anss/catalog-search.html.

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Figure D.9-3
Active Faults and Historic Earthquakes

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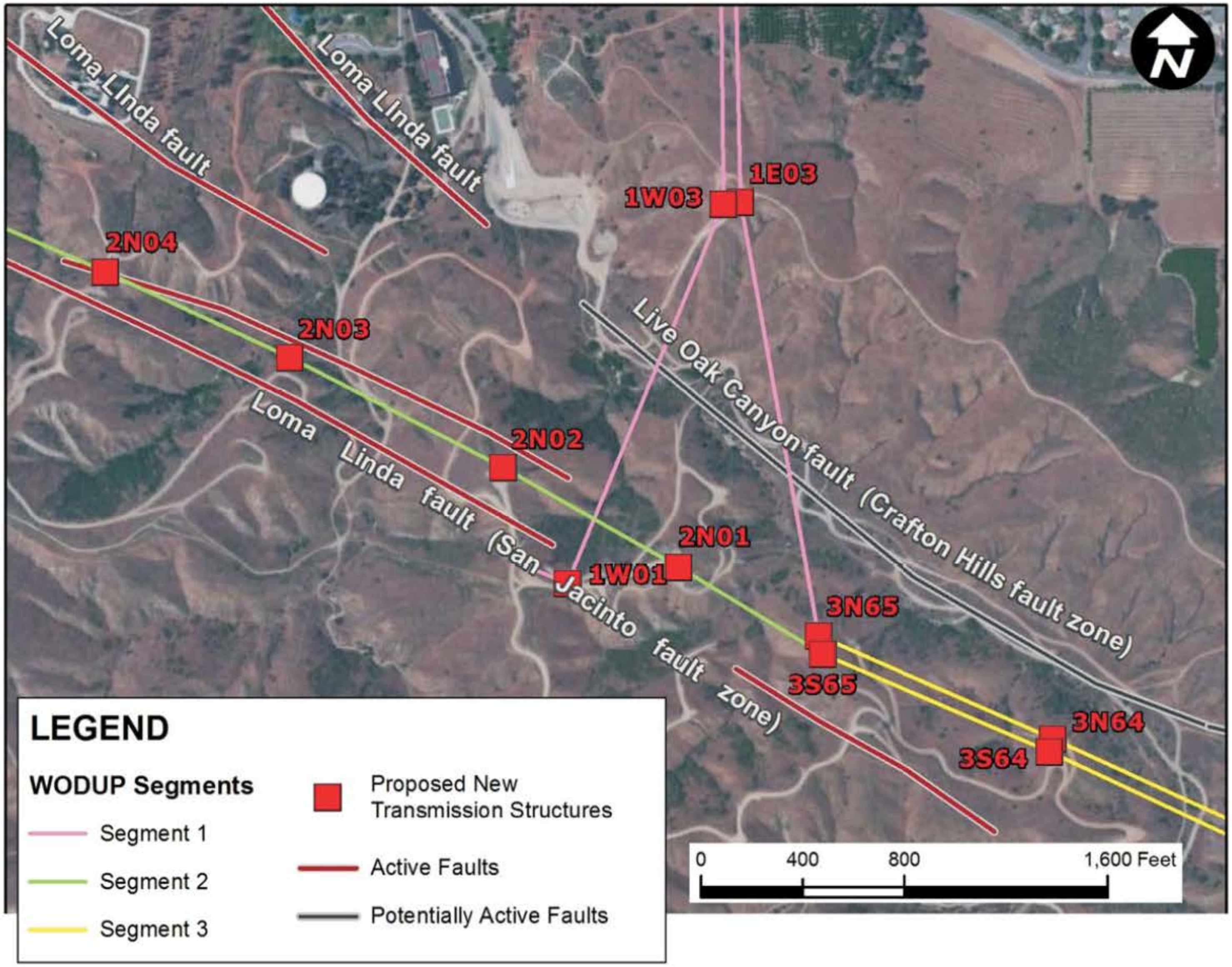

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Figure D.9-4a

Segment 1 Fault Crossings

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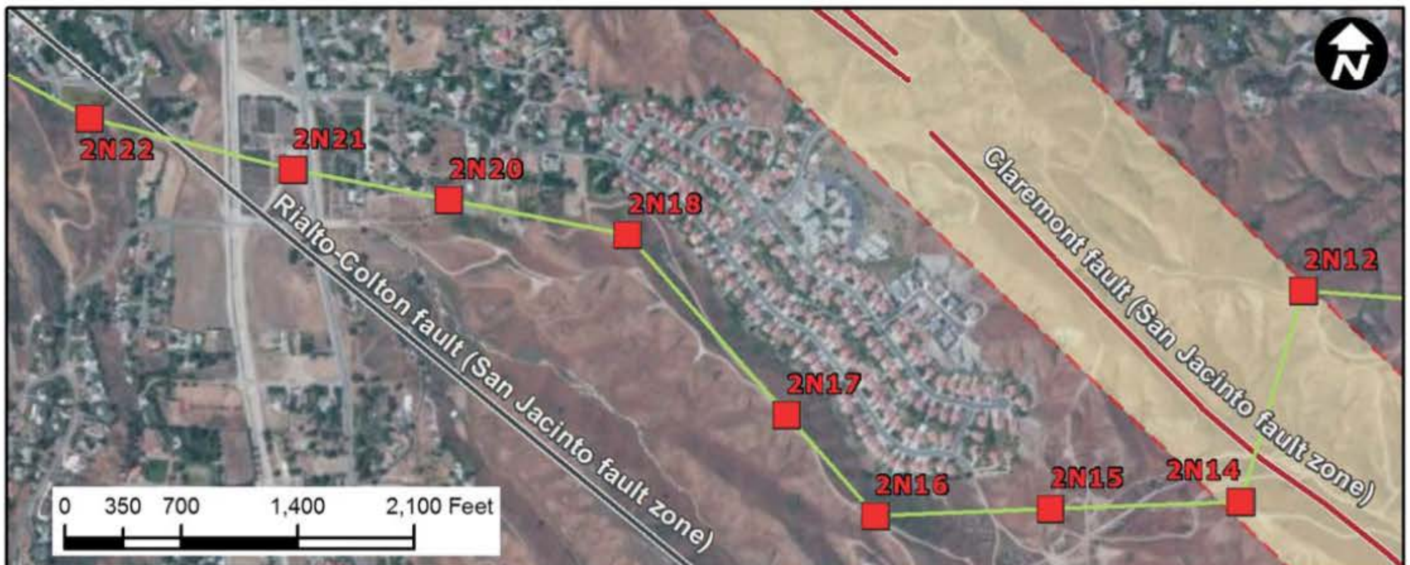

LEGEND

WODUP Segments

Segment 1

Segment 2

Proposed New Transmission Structures

Active Faults

Potentially Active Faults

Alquist-Priolo Earthquake Fault Zone

West of Devers Upgrade Project

Figure D.9-4b

Segment 2 Fault Crossings

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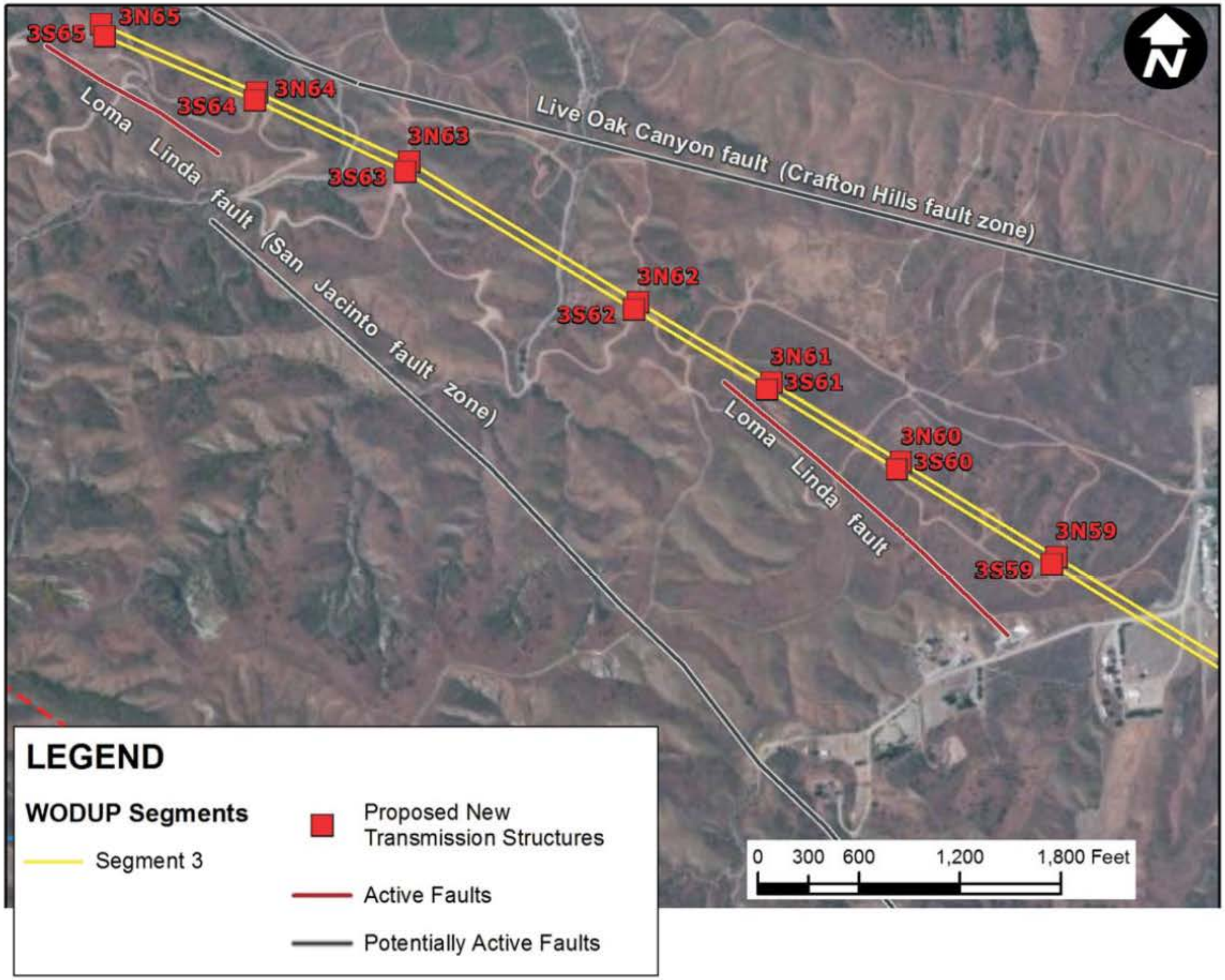

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Figure D.9-4c

Segment 3 Fault Crossings

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LEGEND

WODUP Segments

Segment 4

Proposed New Transmission Structures

Active Faults

Potentially Active Faults

Riverside County Mapped Fault Traces

County of Riverside Fault Zones

West of Devers Upgrade Project

Figure D.9-4d

Segment 4 Fault Crossings

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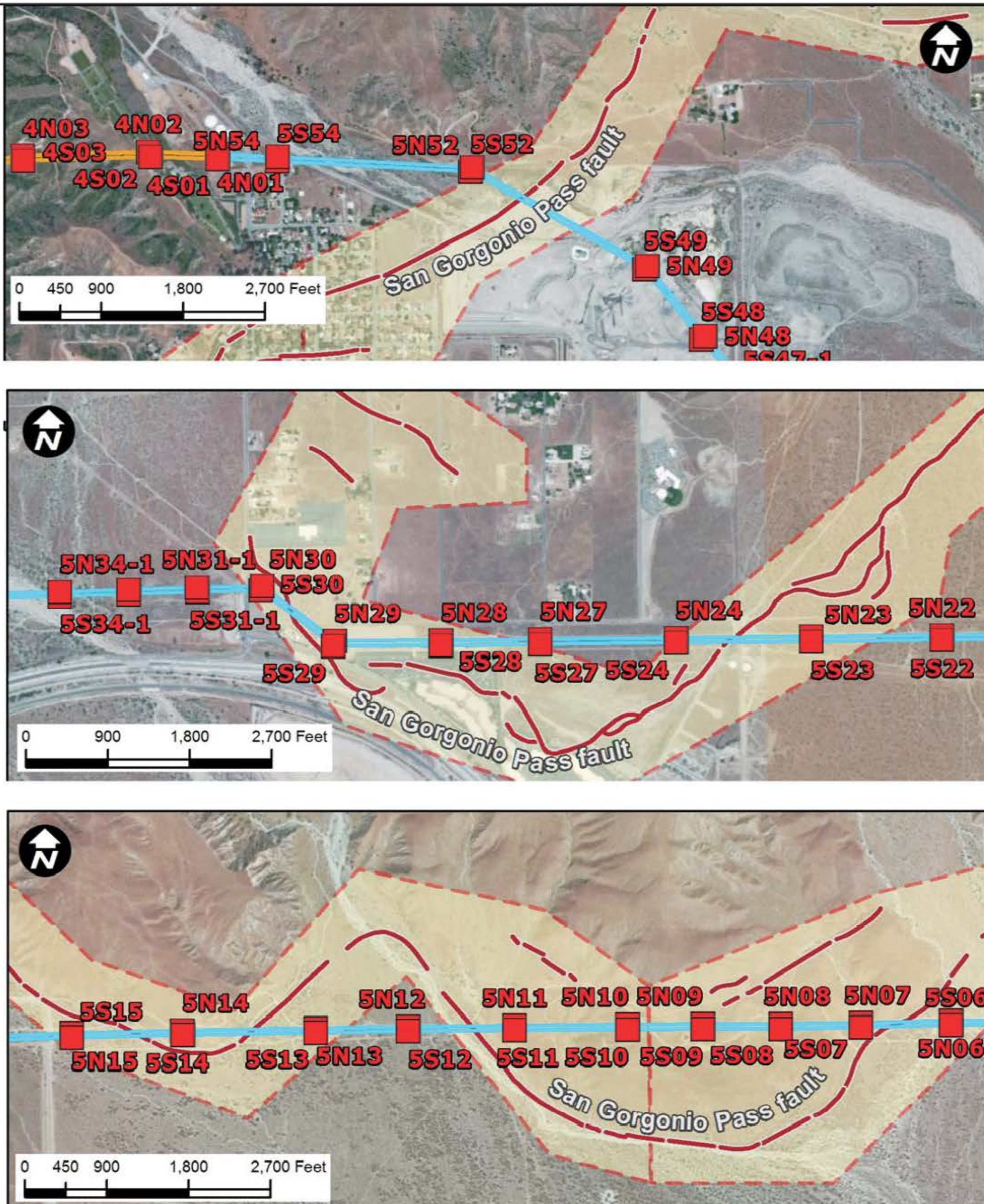

Segment 4

Segment 5

Active Faults

Potentially Active Faults

Proposed New Transmission Structures

Alquist-Priolo Earthquake Fault Zone

West of Devers Upgrade Project

Figure D.9-4e

Segment 5 Fault Crossings

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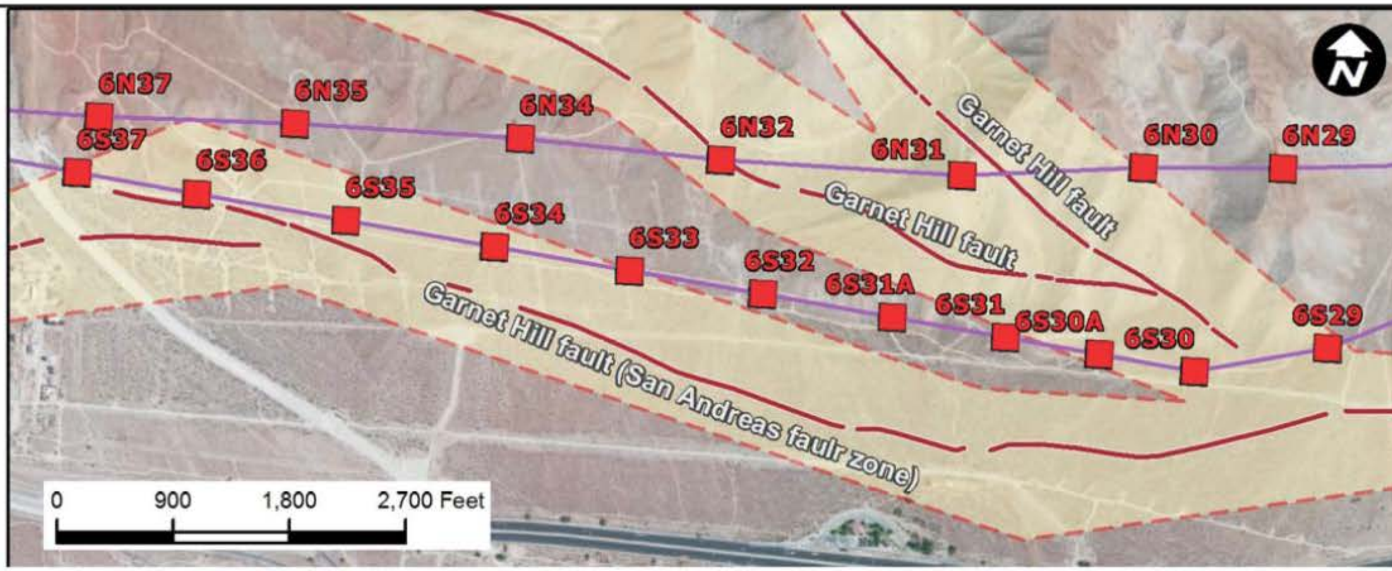

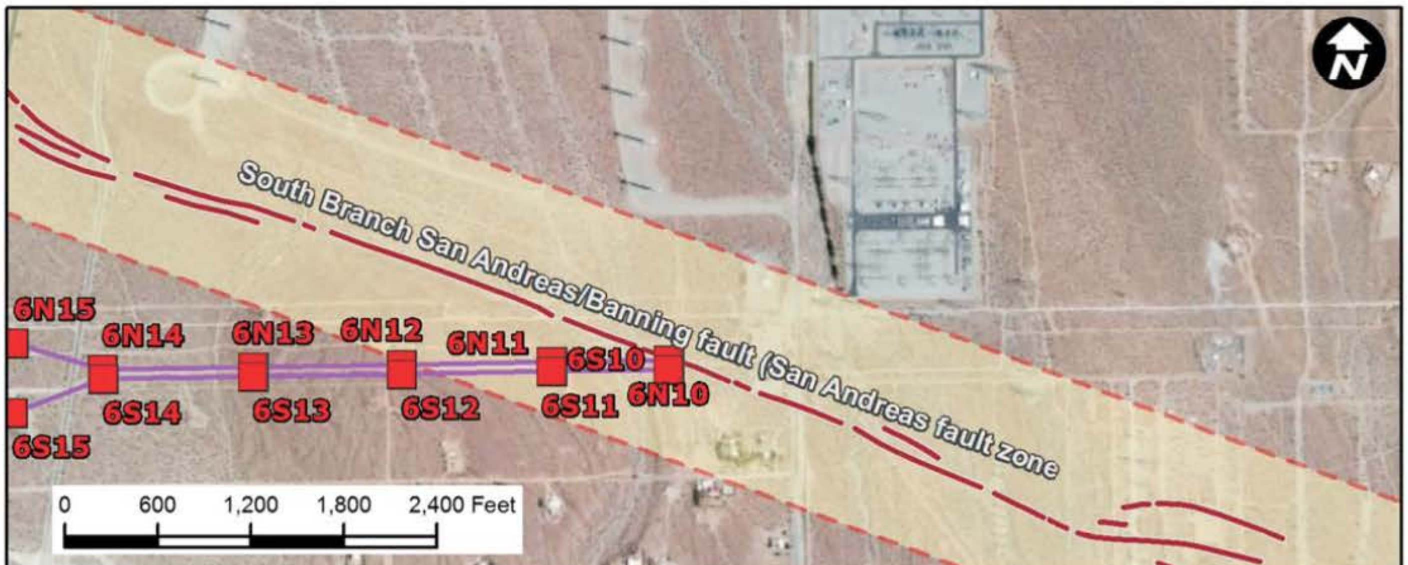

Segment 6

Proposed New Transmission Structures

Alquist-Priolo Earthquake Fault Zone

Active Faults

Potentially Active Faults

West of Devers Upgrade Project

Figure D.9-4f

Segment 6 Fault Crossings

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